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Cover Type Map and Vegetation Classification of the Hagerman Study Area, Southwestern Idaho

Nancy K. Cole
Plant Ecologist

Technical Report
Appendix E.3.3-A

Bliss
FERC No. 1975

Lower Salmon Falls
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Abstract

The purpose of this report is to characterize vegetation of the middle Snake River from Banbury Springs to Bancroft Springs (RM 589.2 to 552.9) in the vicinity of Upper Salmon Falls, Lower Salmon Falls and Bliss Reservoirs including the unimpounded Thousand Springs, Wiley and Dike Reaches. The first objective was to develop a map of general cover types found in the study area. The second objective was to develop a classification system for plant associations found in each of the vegetation cover types.

A total of 27 vegetation, natural feature and land use cover types were found in the Hagerman Study Area. Aquatic habitats, consisting of the river and nearby ponds, account for 14.8% of the total area. Land use cover types, dominated by agriculture and grazed pastures, occupy 21.6% of the total area, and vegetation cover types account for the remaining 54.3%. Wetland/riparian vegetation cover types account for 7% of the total area and only 12% of the area occupied by vegetation cover types. Upland vegetation cover types account for 88% of the area occupied by vegetation cover types. *Lotic*, *Shrubland* and *Shrub Savanna* cover types were the most abundant of the cover types present. *Shore* & *Bottomland Wetland* and *Forested Wetland* cover types were strongly associated with specific reaches of the study area. Twenty-two riparian and wetland plant associations and four upland associations were identified. ***Salix exigua*** occurs as a significant component in 65% of the riparian and emergent wetland associations defined as part of this study and almost half of the associations were dominated by ***Salix exigua***. In upland associations, ***Bromus tectorum*** was the most common understory species. All of the plant associations described have exotic species as an integral component of their composition. Three cover types were sampled insufficiently to describe plant associations: *Tree Savanna*, *Upland Forest* and *Grassland*.

1. Introduction

Little information describing the vegetation resources of the Snake River in southwestern and western Idaho exists upstream of the Hells Canyon region. A brief description of upland and riparian plant communities was provided for the Wiley Reach (Jensen and Verhovek 1979, Idaho Power Company 1979, Bowler 1981). Renewal of Federal Energy Regulatory Commission (FERC) operational licenses for three hydroelectric dams operated by Idaho Power Company (IPC) on the Snake River, begins in 1995. The content of renewal applications was expanded with the passage of the Electric Consumer's Protection Act in 1987 to include mitigation and amelioration of environmental impacts resulting from operation of hydroelectric facilities. Documentation regarding vegetation that accompanies a relicense application must include 1) a description of existing plant communities occurring in the proposed study area and its vicinity, 2) identification of any species listed or proposed for listing by the United States Fish and Wildlife Service, 3) identification of impacts, if any, to vegetation as a result of project operation and 4) plans to mitigate for impacts (18 CFR Ch.I, Subpart E §4.41 (1991)). To be consistent with FERC requirements and to provide a basis for ecological evaluation of existing vegetation conditions, IPC sampled vegetation throughout the study area with the objective to describe vegetation resources. The purpose of this report is to characterize vegetation of the middle Snake River from Banbury Springs to Bancroft Springs (RM 589.2 to 552.9, hereafter referred to as the Hagerman Study Area), in the vicinity of Upper Salmon Falls, Lower Salmon Falls and Bliss Reservoirs, including the unimpounded Thousand Springs, Wiley and Dike reaches, with respect to land use and vegetation cover types and plant associations affiliated with each vegetation cover type. The goal of this project was to describe the botanical resources that occur in the Hagerman Study Area. The first objective was to develop a map of general cover types found in the study area. The second objective was to develop a classification scheme for plant communities found along the Snake River. Cover type maps can be used to identify biologically sensitive areas (Scott et al. 1987), describe spacial patterns (Malanson 1993) or changes in abundance and frequency of particular characteristics of the landscape, e.g., Habitat Evaluation Procedure (HEP; USFWS 1981). Development of vegetation classification systems is critical for relating land management programs (Padgett, Winward and Youngblood 1987) to the short and long term impact of management decisions upon successional changes in plant communities. Taxonomy follows Kartesz and Kartesz (1980).

2. Study Area

2.1. Location

The Hagerman Study Area is located on the Snake River Plain in southwestern Idaho, near the communities of Hagerman and Bliss (Figure 1). It encompasses approximately 43 km of the Snake River and extends for 1.6 km on either side of the river. The elevation of the study area ranges from 762 to 1036 m above mean sea level incorporating a deeply incised basalt channel cut into the surrounding plain. Three hydroelectric projects fall within the study area, Upper Salmon

Falls Dam (plants A and B), Lower Salmon Falls Dam, and Bliss Dam and the impoundments associated with each project. Each project has a legally defined project boundary incorporating physical structures and impoundments. All three projects are "run-of-the-river", and have little storage capacity. There are three unimpounded reaches present. The first is the Thousand Springs Reach, between Banbury Springs and the Upper Salmon Falls impoundment, the second is the Wiley Reach, between Lower Salmon Falls Dam and Bliss Reservoir and the third is the Dike Reach, located from Bliss Dam to Bancroft Springs. Major tributaries to the Snake River within the study area include the Malad River, Salmon Falls Creek, Riley Creek and Billingsley Creek. Additional significant inflows originate in the Thousand Springs spring complex from Niagara Springs (RM 600.8) to Owsley Bridge (RM 585.4).

2.2. Climate

The climate of the study area is semi-arid because of an orographic rainshadow created by the Cascade Mountain Range (Caldwell 1985, Franklin and Dyrness 1988, West 1988). Total precipitation per year averages 216 mm (9.6 in.) (NOAA, Bliss weather station, 1951-1980). Mean annual temperature averages 10.6° C (51.0° F). Summers are typically hot and dry. Average precipitation for the summer months is 7.9 mm (0.35 in.) and daytime temperatures regularly exceed 37.8 °C (100 °F) during July (NOAA, Bliss weather station, 1951-1980). Generally, precipitation that falls during the summer does not percolate into the soil beyond the surface layer (Caldwell 1985, West 1988), instead it is primarily lost through evaporation and runoff. Winters are typically cold and moist. Most of the precipitation falls during the winter months as snow (Figure 2). Snowmelt provides most of the stored moisture in the soil profile that is available to vegetation (Caldwell 1985, West 1988).

2.3. Vegetation

Presettlement vegetation specific to the Snake River corridor is poorly known. A handful of illustrations were made in the mid to late 1800's that clearly identify ***Artemisia tridentata*** (big sagebrush) as the dominant overstory species (Settle 1940, Fremont 1845). There have been numerous attempts to describe the botanical features of southwestern Idaho since the first recorded collecting trips made in the early and mid-1800's by John C. Fremont and John McLeod. Unfortunately, most collectors were less interested in describing plant communities than individual species (D. Henderson, Univ. of Idaho, *pers. comm.*); thus historians are left with an incomplete picture of the historical organization of Idaho's vegetation landscapes. Descriptions of pristine vegetation are based primarily upon existing conditions at sites that are thought to be undisturbed and from historic data collected elsewhere in the Intermountain Region of the northwestern United States.

2.3.1. Upland Vegetation

The study area falls within the physiographic province identified as the Columbia-Snake River Plateau (West 1983*a*, 1988), also described as the Intermountain Sagebrush Province (Bailey 1978). Upland areas have been classified by West (1983*b*) as part of the Western Intermountain Sagebrush Steppe. Some authors include the study area within the extent of the Great Basin flora (Hidy & Kleiforth 1990), although the area does not coincide topographically with the physiographic boundaries that define the Great Basin.

Artemisia species coupled with an understory of perennial bunchgrass including ***Agropyron, Poa***, ***Stipa*** and ***Oryzopsis*** species, are typical of sagebrush steppe. Once thought to be subclimax to perennial grassland communities (Shantz and Zon 1924, Weaver and Clements 1938, Clements and Clements 1939), sagebrush-grass vegetation is now thought to be ecologically stable. Local shifts in composition can occur rapidly and frequently in response to climatic conditions (Blaisdell 1958, Sharp et al. 1990), but overall composition and abundance have been shown to be stable (Anderson and Holte 1981).

Much of the sagebrush-bunchgrass vegetation has changed from pristine to disturbed condition since human occupation, beginning essentially with the adoption of horses by Native Americans around 1700 AD (Yensen 1982). A number of factors have combined to cause a sometimes severe alteration of the natural ecological state, including grazing, agriculture, fire, and introduction of exotic species.

Prior to European settlement, Shoshone-Bannock Indians kept a considerable number of horses. The Shoshone-Bannock were known to winter in large encampments on the Snake River Plain near the mouth of tributaries to the Snake River, grazing their horses on the nearby bottomlands (Yensen 1982). The herds undoubtedly exerted a significant impact on the local vegetation.

Early pioneers complained of insufficient grass to support their herds of cattle as they traveled across Idaho during the early 1800's (Yensen 1982). As increasing numbers of people traveled west, conditions worsened. By the 1840's there were camps along the Oregon Trail which no longer supported grass. By the time of peak emigration, cattle were commonly found dead along the trail. Yensen (1982) estimates between 60,000 and 250,000 cattle passed over the Oregon trail annually during the period of peak emigration.

Permanent settlement within the vicinity of the Hagerman Study Area began in the 1870's with the establishment of the Bliss Ranch near the present day community of Bliss (Ostrogorsky 1981). Ranches were becoming prevalent during this time period in response to the increasing number of miners working in Idaho. The number of cattle, sheep and horses being trailed through Idaho along the Oregon Trail to railheads in Wyoming and Utah increased to about 100,000 by 1879 (Hutchinson and Jones 1989). When the Union Pacific Railroad came to the area in 1885, the town of Bliss became a staging area for grazing herds waiting to be shipped. Conditions were similar across the western United States and, by the turn of the century, vast areas of sagebrush-bunchgrass vegetation were in poor condition (Lenz 1986).

The bunchgrasses of the sagebrush steppe did not evolve with extensive sizeable herds of large, hooved herbivores (Young et al. 1976, Tisdale and Hironaka 1981, Mack and Thompson 1982, Mack 1986) and were quickly depleted by domestic grazing animals during the emigration periods (Yensen 1982). Under heavy grazing pressure the density of ***Artemisia*** spp. and other unpalatable woody species (e.g., ***Chrysothamnus*** spp. (rabbitbrush)) tends to increase.

Overgrazing by domestic animals was not the only cause of the deterioration of the sagebrush-bunchgrass vegetation. Commercial placer mining was occurring upstream at Shoshone Falls around 1869 (Miss and Campbell 1988) and began in the Hagerman Valley in 1887 when the Montana Land and Mining Company began large scale placer mining efforts there. The development of widespread agriculture began with the arrival of the railroad. Later, conversion of ***Artemisia***-dominated lands to agriculture occurred with the invention of powerful electric pumps that enabled farmers to move water from the river to the surrounding plateaus. With the long history of intensive land use, it was inevitable that changes to the vegetation of the Snake River Plain would occur.

The disturbance of native vegetation and the settlement of the West by emigrants was accompanied by the introduction of numerous exotic weedy species. One of the most well known and widespread exotics is ***Bromus tectorum*** (downy brome). Areas typically invaded by ***Bromus tectorum*** carry more or less continuous fine fuels and are dry enough to carry a fire (Whisenant 1990). With the shift from native rangelands dominated by perennials toward annual grasslands, fire frequency of ***Bromus tectorum***-dominated rangelands in Idaho has increased to 3-5 year intervals (Whisenant 1990). Natural diversity has been significantly reduced as a result (Whisenant 1990). Increased soil erosion results, not only from reduced vegetative cover, but from the loss of soil surface cryptogams as well (Marble and Harper 1989). Combined with poor grazing practices, recovery of native sagebrush-bunchgrass vegetation through natural successional pathways is altered, if not eliminated (Whisenant 1990).

2.3.2. Riparian and Emergent Wetland Vegetation

Juxtaposed upon the dry landscape are narrow bands of riparian vegetation that follow perennial water courses. In this setting, trees and tall shrubs, such as ***Salix*** spp. (willows), replace the ***Artemisia*** spp. and the diversity of grasses and forbs increases (Mitsch and Gosselink 1993). Within the narrow band, numerous riparian communities are distributed along a moisture gradient from emergent wetland to vegetation transitional between wetland and upland communities (Myhre and Clements 1972, Jensen and Verhovek 1979, Tisdale 1986, Minshall et al. 1989, Johnson et al. 1992). Species are also distributed in response to local changes in soils, topography, and, at least historically, seasonal disturbance frequency, e.g. flooding (Mitsch and Gosselink 1993, Sather-Blair 1988).

Flooding is a natural ecological disturbance that greatly affects the composition and arrangement of species within the riparian corridor (Szaro 1989). Most riparian species are well adapted to periodic disturbance because of the dynamic nature of their natural environment.

Cowardin et al. (1979) provided a general classification of riparian and wetland vegetation cover types for the United States based primarily on physiognomic status, but also involving physiographic (e.g., lake/river), substrate (e.g., consolidated gravel/bedrock) and hydrologic (e.g., seasonal intermittent flow) characteristics. The classification was used to map the distribution of wetland types across the United States (USFWS National Wetlands Inventory, NWI). Three cover types are common on NWI maps of Idaho: *Emergent*, *Scrub-Shrub*, and *Forested Wetland* (Sather-Blair 1988). In general, *Scrub-Shrub* vegetation is dominant along the water's edge, with forested species occurring slightly up-slope (Sather-Blair 1988, Johnson et al. 1992). Within the riparian zone, herbaceous species tend to be more common at the wetter edge of the moisture gradient (Myhre and Clements 1972, Jensen and Verhovek 1979, Johnson et al. 1992). A total of 659.9 ha of wetlands were identified on NWI maps for the Hagerman Study Area (Table 1). The most abundant wetland types in the study area are *Palustrine, Scrub-Shrub Wetlands* (27.0%) and *Palustrine, Emergent Wetlands* (25.6%). All other types of wetlands compose less than 15% each of the total wetland area.

Flooding maintains riparian systems by creating new habitat, distributing nutrients, and by importing and exporting organic material (Etherington 1983, Mitsch and Gosselink 1988). Steep channel slopes, like those found in the study area, tend to have less widespread flooding (Mitsch and Gosselink 1988), therefore limiting the size of the riparian zone. Ultimately, hydroperiod, including flood intensity, duration, and timing, determines ecosystem function and structure (Mitsch and Gosselink 1988, Klimas 1988). Seasonal flooding also maintains wetland and riparian habitats in early successional stages (Etherington 1983), leading to a more diverse vegetation than occurs in surrounding vegetation (Klimas 1988).

Grazing impacts to riparian vegetation are similar to those described for *sagebrush-bunchgrass* vegetation. Livestock tend to congregate along waterways because water and shade are available as well as forage (Szaro 1989). Impacts can include change in vegetative composition, a lowered water table, and complete loss of riparian cover (Minshall et al. 1989, Szaro 1989). Many of the native shrub species resprout after defoliation by grazing livestock, but only if sources of regeneration remain on site (Hansen 1992). Noxious weed species generally find open habitat available for colonization in heavily grazed riparian systems (Hansen 1992). Like the vegetation of the sagebrush-bunchgrass type, examples of pristine riparian vegetation on the Snake River Plain are rare.

2.3.3. Land Use

In the 1860's ranchers grazed large herds of cattle in southern Idaho (Yensen 1982) to provide food for the growing population of miners (Young 1986). By the 1880's, large cattle ranches were common. Sheep herding also became more common about this time (Yensen 1982, Young 1986). The Raft River Valley was a route commonly used to drive sheep from Utah and Nevada into the mountains of Idaho for summer grazing. Herds were also driven into Idaho during the winter to avoid grazing taxes in Utah (Yensen 1982). Young (1986) describes the Raft River Valley as a "...dust bowl as a result of the migrations." An 1880 census reported 27,326 sheep in Idaho. In 1890, a census listed 357,712 sheep (Young 1986). The years 1889 and 1890 brought two of the coldest and snowiest years recorded. Extreme weather conditions, combined with a decade of severe overgrazing, devastated herds of cattle and sheep. Subsequently, hay farming on irrigated land soon became a common practice to provide reliable winter food for cattle (Young 1986) and sheep (Yensen 1982). The Hagerman Valley surrounding Upper and Lower Salmon Falls Reservoirs was extensively used for irrigated agriculture for almost a century because of the availability of numerous springs along the east side of the Snake River. Upland areas that were not irrigated were grazed by livestock.

Following the passage of the Carey and Desert Land Entry Acts, private organizations and the federal government rushed to build irrigation facilities to divert the flow of the Snake River and tributaries onto the desert landscape in order to "reclaim" the land for agriculture. Irrigation projects became commonplace and agriculture became an important source of income for the region (Miss and Campbell 1988). One of the earliest large-scale reclamation projects undertaken on the Snake River began in the early 1900's at what is now known as the Milner Dam site. Large numbers of would-be farmers emigrated from the eastern and middle United States to take advantage of new government regulations (e.g., Carey Act, Enlarged Homestead Act) that provided up to 320 acres of land (Yensen 1982) to any man, woman or child willing to convert the arid West into farmland (Greenwood 1987). Many of these farms failed, especially during the drought and depression years of the 1930's, leaving behind large areas denuded of vegetation.

In the late 1950's technology became available to build powerful electric pumps to irrigate upland habitats on the benches above the Snake River. Subsequently, large tracts of ***Artemisia***-dominated lands were developed for agriculture (Stacy 1991). Currently, much of the upland areas on the benches, as well as much of the Hagerman Valley are under cultivation. Nearly 500,000 acres of the surrounding counties have been converted to cropland (J. Grover, Consolidated Farm Services Agency, *pers. comm.*). This amounts to 20% and 25% of the total land acreage in Gooding and Twin Falls counties, respectively. Uncultivated areas are generally grazed with exception of the Hagerman Fossil Beds National Monument, which has not been grazed since the early 1980's.

3. Methods

3.1. Cover Typing and Mapping

A cover type map was developed for the study area based on 27 vegetation, natural feature and land use cover types categorized by the Habitat Evaluation Procedure (HEP). This classification system was chosen because it is a standard classification widely used by state and federal agencies to classify land status (USFWS 1981) (Table 2 and Appendix 1). Vegetation cover types include riparian and upland vegetation. Natural feature types include cliff and talus slopes, barren lands, and open water. Agriculture, grazing lands, and orchards were included in land use cover types along with roads, urban areas, etc. Wetland cover types correspond to the classification system described by Cowardin et al. (1979). One additional cover type, called the *Non-Emergent Herbaceous Wetland* cover type, was created for non-emergent riparian vegetation dominated almost exclusively by herbaceous species. This category of vegetation cover type was not part of the existing HEP classification. Upland vegetation, natural features and land use were classified using existing HEP cover types as outlined in USFWS (1981). Impounded reaches of the river were typed as *Lotic* because the reservoirs are run-of-the-river. Photos were typed from stereo pairs with 60% image overlap. A minimum distance of 500 m from each bank was typed except when limited by the useable coverage of the aerial photographs. Cover type polygons were delineated from 1989 (1:6,000) true color aerial photographs, traced onto Mylar overlays, identified, and ground truthed in September 1993.

Elevation contour lines of the study area were digitized from 7.5 minute U.S. Geologic Survey (USGS) topographic maps using Arc/Info® 6.1.1. Transparent orthophotoquads of the study area were created at 1:12,000 scale (Nies Mapping Group, Bellevue, Wash.), utilizing the elevation contour lines and 1:24,000 nominal scale aerial photography. The orthophotoquads were used for geometric control to digitize the interpreted cover type polygons using standard Arc/Info® digitizing techniques. Polygon topology was created and each polygon was labeled. Fixed points located on the aerial photographs were used to "rubber-sheet" the polygons to correct for distortion within the photographic images. Points identifiable in the data layer and on the orthophotoquads were marked as Arc/Info® links and the data layer was stretched into the proper position.

3.2. Vegetation Classification

In 1987, a draft cover type map was developed from aerial photography. The classification system was much simpler than the HEP system. The 1987 draft maps identified two vegetation cover types: upland and riparian. Based on the draft maps, 45 sampling points were selected at random: 22 in upland vegetation and 23 in riparian vegetation. Only sites occurring within 1.6 km (1 mi) of the Snake River Canyon were included. A preliminary protocol was developed. As the sampling effort expanded, the protocol was modified. In total, 99 transects were sampled. Twenty-two were in upland vegetation and 77 were in riparian vegetation (Figure 3). Subsequently, the cover types were remapped to conform to HEP. A new cover type map was developed in 1993 by the Idaho Department of Fish and Game under contract to Idaho Power Company. The modification of the map resulted in the identification of some types previously unidentified on the draft map. Consequently stratification among all cover types was not accomplished, resulting in undersampling of some cover types.

3.2.1. Upland Vegetation

A 100 m line transect was oriented in a randomly selected direction. Roads, large trails or other clearly defined modifications to the landscape were avoided. If the random point fell on a steep slope, the transect was placed perpendicular to the slope. Species presence and cover were determined for each transect.

Cover of upland species was determined using the 0.10 m^2 quadrat (Daubenmire frame) and six cover classes described by Daubenmire (1959). Quadrats were placed at 1 m intervals along the transect and cover of each species was estimated. Cover estimates were made for tracheophyte species and surface cryptogams (moss and lichen), rock, litter and rooted dead trees and shrubs. Inflorescences were not included in the cover estimate and grass cover was based on the basal area of the plant (Floyd and Anderson 1982). Woody upland species with height greater than 5 m were classified as trees. All other woody species were identified as shrubs.

3.2.2. Riparian and Emergent Wetland Vegetation

The riparian vegetation was defined by the dominance of facultative and obligate wetland species (see Reed 1988). Along the Snake River, the riparian zone is usually composed of a number of linear plant communities oriented parallel to the river. These communities are distinguished by their vegetative physiognomy (e.g., dominated by herbaceous or woody vegetation, shrub or tree lifeforms), topographic position (e.g., adjacent to water, below the daily water high mark) and edaphic-hydrologic conditions (e.g., soils in standing water; soils saturated at or near the surface; soils below the mean annual high water mark, but not saturated; etc.). The communities were visually delineated in the field. Transects were centered longitudinally in each. Commonly, more than one community was represented along a gradient from standing water to upland vegetation. In order to sample all communities present at a location, a 'base' transect 100 m long was placed parallel to the river bank. Sampling occurred at 10 m intervals along the base transect. At each interval all plant communities occurring along a line placed perpendicular to the base transect were identified. The perpendicular line was always oriented along the moisture gradient from wet to dry. The width of each community was measured along the perpendicular line. Boundaries between communities were based on apparent changes in the physiognomy, species dominance, edaphic, hydrologic and topographic characters defined earlier. Once each community along the perpendicular line was delineated, cover and frequency of all species occurring on the line were estimated using the Daubenmire technique. Four Daubenmire frames were placed at regular intervals within the community using the following methods. Communities intercepted by the perpendicular lines for more than 3 m were sampled along the perpendicular line. Narrow communities intercepted by less than 1 m were sampled along an axis parallel to the base transects with Daubenmire frames on either side of the perpendicular line. Communities larger than 1 m wide, but narrower than 3 m were sampled with two frames placed on either side of the perpendicular line (Figure 4). Using this design, a maximum of forty frames could be sampled for each community. Those communities that were not intercepted by all perpendicular lines had fewer than forty frames. Consequently the total number of frames sampled was related to the frequency at which a particular community occurred along the base transect. Cover estimates for species occurring within a frame were made following the same protocol described for upland vegetation sampling except woody riparian species with height greater than 6 m were classified as trees.

3.3. Analyses

3.3.1. Cover Type Acreage

Total acreage and relative abundance of each cover type occurring within 500 m of either side of the Snake River were calculated. Total acreage and relative abundance were also calculated for all cover types present within the legally defined project boundaries associated with each hydro-facility occurring within the study area. Five hundred meters was the approximate maximum typeable area on the aerial photos of the study area.

3.3.2. Classification of Vegetation Data

Cover estimates for three physiognomic types (tree, shrub and herb) were calculated for each upland transect and for each community encountered on a riparian transect. The cover estimates were then used to classify each transect or community into a HEP cover type based on total cover and the abundance of one or more physiognomic types. If two or more communities from the same riparian transect fell within the same cover type, the data were combined. Because of the difficulty encountered in taxonomic identification of arboreal willow species growing along the river, the species were treated as a single entity (***Salix*** spp.).

Data representing a HEP cover type were classified into vegetation associations using TWINSPAN (Two-Way-Indicator-Species-Analysis, Cornell Labs, Ithaca, NY). Cover types that were represented on fewer than three transects were excluded from classification analyses because of the small sample size. TWINSPAN is a polythetic, divisive method of classification that groups species and transects by "progressive refinement of single axis ordination from reciprocal averaging..." (Kent and Coker 1992). Multiple dichotomies are created until no significant dissimilarities are found within a group or a minimum sample size of three transects is reached. Generally, dichotomies beyond the third level are not considered in classification (Kent and Coker 1992, Gauch 1989, Jongman et al. 1987). The strength of each dichotomy is measured using eigenvalues calculated during each ordination. Eigenvalues describe the amount of variation explained by a particular ordination axis (Kent and Coker 1992, Gauch 1989, Jongman et al. 1987). The larger the eigenvalue, the more variation is accounted for by the axis and the more similar are members of the group relative to other groups. Eigenvalues were used to determine which dichotomies were the strongest.

Once all members of an association were defined, the average cover for the three physiognomic groups, the average cover for each species, and the diversity and evenness for each association and cover type were calculated. The dominant species in each physiognomic layer were identified and used to name the vegetation association. In cases where two species from the same physiognomic group were dominant both names were used. In the title, species of the same physiognomic group are separated by a hyphen; species from different physiognomic groups are separated by a slash (*sensu*, Franklin and Dyrness 1988). Diversity was measured using the Shannon-Weiner Index (H') (Shannon and Weaver 1949, Pielou 1969):

$$H = \sum_{i=1}^{S} p_i \log p_i$$

where p_i = relative importance value of the *i*th species.
Variance of H' (Magurran 1988) was calculated as:

$$Var(H) = \frac{p_i(\ln p_i)^2 \;(\quad p_i \ln p_i)^2}{N} \quad \frac{S1}{2N^2}$$

where S is the total number of species and N is the total number of individuals sampled. Evenness (J) (Kent and Coker 1992) was calculated as:

$$J = \frac{H}{\ln S}$$

where S is the total number of species. The Shannon-Weiner index generally falls between 1.5 and 3.5 (Margalef 1972) while evenness can range between 0 and 1.0 (Magurran 1988). Relative cover and relative frequency of each species, expressed as a proportion and summed, were used as an importance value.

A wide variety of plant species were found in each association. Most of the species were rare and sometimes found only on a few transects. Cover values for most species, as represented in these analyses, were depressed because they were reported as an average for all transects falling within an association. Frequency of occurrence across transects may be as useful as cover as an indicator of representation within an association. Therefore relative frequency and average cover were used together to identify dominant, characteristic species for each association.

4. Results

4.1. Cover Type Map

The 500 m zone along each side of the river encompassed a total of 6250.0 ha. All but 7.9% of the area was successfully typed. Untyped areas occurred when aerial photos did not provide sufficient coverage for photo interpretation to occur. Within the typed area 14 vegetation cover types, four natural feature cover types and nine land use cover types were identified (Figure 5). Ponds, reservoirs and unimpounded river reaches accounted for 14.8% of the total area; cliffs and talus slopes and naturally barren lands occupied 1.5% of the total area; land use cover types occupied 21.6% of the total area, and vegetation cover types accounted for 54.3% (Table 3). Wetland/riparian vegetation cover types account for 6.8% of the total area and only 12% of the area occupied by vegetation cover types. Upland vegetation cover types account for 88% of the vegetation cover types. The most abundant cover type was *Shrubland* (1770.8 ha, 28.3%), followed by *Lotic* (885.0 ha, 14.1%), and *Shrub Savanna* (553.5 ha, 8.9%) (Table 3). The most abundant land use cover types were *Agriculture* (500.7 ha, 8.0%), *Grazing Land/Pasture* (481.4 ha, 7.7%) and *Disturbed* (125.3, 2.0%).

Within the individual project boundaries, the most common cover types included *Lotic* (37.5 ha, 25.4%), *Shrubland* (30.2 ha, 20.5%), and *Scrub-Shrub Wetland* (16.7 ha, 11.3%) cover types at Upper Salmon Falls and Lower Salmon Falls hydroelectric projects (300.1, 83.1%; 16.5 ha, 4.6%; and 13.8 ha, 3.8%; respectively) and *Lotic* (109.5 ha, 63.7%), *Shrubland* (19.9 ha, 11.6% and *Shrub Savanna* (12.9 ha, 7.5%) at the Bliss Project (Table 4). Riparian and emergent wetland cover types were less common in the Bliss Project Area than elsewhere. The poorly vegetated *Shore & Bottomland Wetland* cover type occurred only in the Bliss Project Area. The *Desertic Herbland*, *Forested Upland* and *Urban* cover types were absent within the projects' boundaries although present within the study area.

4.2. Association Classification

Twenty six plant associations, from 10 cover types, were delineated from the vegetation data (Table 5). Three cover types were not sampled sufficiently to determine what plant associations were affiliated with them because of their rarity. These include *Forested Upland*, *Tree Savanna* and *Desertic Woodland*. Two cover types, *Desertic Shrubland* and *Grassland* cover types, were not represented in the vegetation data base. ***Salix exigua*** occurs as a significant component in 65% of the riparian and emergent wetland associations defined in this study and almost half of the associations are dominated by ***Salix exigua***. In upland associations, ***Bromus tectorum*** was the most common understory species.

4.2.1. Emergent Herbaceous Wetland Cover Type

Criteria for the *Emergent Herbaceous Wetland* cover type included total cover greater than 30% and woody cover less than 30% (Appendix 1). A total of 52 species composed the flora of this cover type. Average total cover was 56.2% (±19.8). Average tree cover was 0.4% (±1.5), shrub cover was 3.7% (±6.4), and herbaceous cover was 52.3% (±18.8). The diversity of the *Emergent Herbaceous Wetland* cover type along the middle Snake River was low (*H'*=1.2, Var (H')=2.5).

Four associations were delineated (Appendix 2): ***Nasturtium officinale-Polygonum persicaria*** association (watercress-ladysthumb), ***Scirpus acutus-Veronica anagallis-aquatica*** (hardstem bulrush-water speedwell), ***Scirpus acutus-Lemna*** sp. association (hardstem bulrush-duckweed), ***Scirpus acutus-Lemna*** sp.***-Solanum dulcamara*** association (hardstem bulrush-duckweed-deadly nightshade) (Table 6). The four associations broke into two general groups, shallow water/shoreline habitat (***N. aquaticum-P. persicaria***) and deeper water (***S. acutus*** associations). ***Scirpus acutus*** was the most common emergent species encountered on the middle Snake River. With one exception, all ***Scirpus***-dominated transects were found on impounded reaches in the study area while the ***N. aquaticum-P. persicaria*** transects were found primarily on unimpounded reaches.

Nasturtium officinale-Polygonum persicaria

Total vegetative cover averaged 54.8% (Table 6). Herbaceous species dominated (average cover 53.5%). Woody species occurred occasionally as overhanging vegetation. ***Salix exigua*** was the most abundant woody species occurring in this association (average cover=2.5%). ***Nasturtium officinale*** was the most abundant herbaceous species sampled, followed by ***Polygonum persicaria***, ***Bidens frondosa*** (beggars-ticks) and ***Veronica anagallis-aquatica***. Although cover was low (average=2.2%), ***Polypogon monspeliensis*** (rabbitsfoot grass) occurred most consistently across all transects. All five species were typically found along the shoreline of the Snake River in shallow water. Most (65%) of the species present were native. The number of species per transect ranged from 6 to 35. Diversity was low (H'=1.5, Var(H')=1.1). Most of the species encountered were rare, thus evenness was low (J=0.34).

Scirpus acutus-Veronica anagallis-aquatica

Total vegetative cover averaged 47.2% (Table 6). As for other members of this cover type, woody species were rare and occurred as overhanging vegetation. ***Salix exigua*** was the most commonly occurring woody species. Dead woody vegetation was commonly encountered. Herbaceous vegetation was dominated by ***S. acutus*** with ***V. anagallis-aquatica*** as a commonly co-occurring species. ***Typha latifolia*** (common cattail) also occurred frequently, although generally at low cover values. Numerous shoreline species occurred in very low abundance, but were encountered along many of the sampled transects. These included ***Polypogon monspeliensis***, ***N. officinale*** and ***Lycopus asper*** (rough bugleweed). Just over half (54%) of the species present were native. The number of species per transect ranged from 13 to 31. Diversity was low (H'=1.2, Var(H')=0.8). Species were not evenly abundant (J=0.3).

Scirpus acutus-Lemna sp***.***

Total vegetative cover averaged 60.3% (Table 6). This association was dominated by a floating vascular plant, ***Lemna*** sp. (Table 6). The abundance of ***S. acutus*** was similar to that of the ***S***. ***acutus-V***. ***anagallis-aquatica*** association, but ***V***. ***anagallis-aquatica*** was nearly absent. Overhanging shrub cover was very low and dominated by ***Salix exigua***. ***Solanum dulcamara*** occurred frequently, but at low cover. Most (62%) of the species encountered were native. The number of species per transect ranged from 4 to 10, the lowest number of all associations in the *Emergent Herbaceous Wetland* cover type. Diversity was low (H'=1.2, Var(H')=0.2) and species were uneven in abundance (J=0.4).

Scirpus acutus-Lemna sp.***-Solanum dulcamara***

Total vegetative cover averaged 79.3% (Table 6). Herbaceous species, particularly ***Scirpus acutus*** and ***Lemna*** sp., dominated the association. There was very little overhanging woody vegetation. The tree species of the genus ***Salix*** were the most common woody species present (average cover=3.3%). ***Scirpus acutus*** was more abundant in this association than in any other of the *Emergent Herbaceous Wetland* cover types. ***Lemna*** sp., ***Solanum dulcamara***, ***Typha latifolia*** and ***Lythrum salicaria*** (purple loosestrife) account for most of the remaining herbaceous cover. More than half (62%) of the species encountered were native. The number of species per transect ranged from 9 to 13. Diversity was low (H'=1.5, Var(H')=0.4). Species were uneven in abundance (J=0.4).

4.2.2. Non-Emergent Herbaceous Wetland Cover Type

Criteria for the *Non-Emergent Herbaceous Wetland* cover type included total cover greater than 30%, herbaceous cover greater than 30%, woody cover less than 30% and vegetation must be dominated by non-emergent vegetation (Appendix 1). A total of 190 species composed the flora of this cover type. Average total cover was 67.2% (±25.4). Average tree cover was 0.8% (±1.7), shrub cover was 10.9% (±9.0), and herbaceous cover was 55.6% (±25.2). Three associations were distinguished (Appendix 3): ***Salix exigua/Melilotus alba*** association (coyote willow/white sweetclover), ***Chenopodium album*** association (lambsquarter), and ***Dipsacus fullonum/Bromus tectorum*** association (teasel/downy brome) (Table 5). In general, the *Non-Emergent Herbaceous Wetland* cover type tended to be among the most diverse (*H'*=2.0, Var(H')=2.6) of the cover types described in this study.

Salix exigua/ Melilotus alba-Dipsacus fullonum

Total vegetative cover averaged 70.1% (Table 7). Woody species had a low total cover (average cover approximately 11.0%). Trees were rare. ***Salix exigua*** was the dominant shrub species, sharing dominance with the herb, ***Melilotis alba*** (white sweetclover). ***Dipsacus fullonum*** (teasel), ***Euthamia occidentalis*** (western goldenrod) and ***Polypogon monspeliensis*** occurred frequently, although at lower abundances than ***M. alba***. It was not uncommon for substantial areas of rocky substrate to be exposed (cover=17.5%). Native species accounted for

46% of the species sampled. The number of species per transect ranged from 13 to 59. Diversity was moderate (H'=2.1, Var(H')=2.0). Evenness was low (J=0.4).

Chenopodium album

Total vegetative cover averaged 60.0% (Table 7). ***Chenopodium album*** was the predominant species sampled on these transects. It accounted for half of the average total herbaceous cover (54.3%) and had the highest frequency of occurrence. Woody species, especially trees, were rare. ***Salix exigua*** was the most common woody species present with an average 3.1% cover. ***Cirsium arvense*** (Canada thistle) and ***Scirpus acutus*** were also commonly encountered. Slightly over half (52%) the species sampled were native. The number of species per transect ranged from 16 to 2. Diversity was low (H'=1.5, Var(H')=0.3) as was evenness (J=0.4).

Dipsacus fullonum/Bromus tectorum

Total vegetative cover averaged 60.4% (Table 7). This association was strongly dominated by weedy, exotic species. Tree cover was uncommon. ***Fraxinus pennsylvanica*** (green ash) was the only tree species encountered and it occurred on one transect. Numerous shrub species were present, accounting for 14% total cover, although none were widespread. ***Artemisia tridentata***, ***Chrysothamnus nauseosus*** (gray rabbitbrush) and ***Purshia tridentata*** (antelope bitterbrush) were present in low abundance on nearly half the transects. Herbaceous species dominated, accounting for 44.7% cover. The most abundant species was ***Dipsacus fullonum***, followed by ***Bromus tectorum***. ***Lycopus asper***, ***Euthamia occidentalis*** and ***Rumex crispus*** (curly dock) were widespread, though low in abundance. Only 44% of the species present were native. The number of species per transect ranged from 8 to 34. Diversity was low (H'=1.9, Var(H')=0.8) as was evenness (J=0.4).

4.2.3. Shore & Bottomland Wetland Cover Type

Criteria for the *Shore & Bottomland Wetland* cover type are less than 30% total cover, and total woody cover is less than 30% (Appendix 1). The cover type can apply to emergent wetland and riparian vegetation. One emergent association, ***Scirpus acutus-Typha latifolia*** association (hardstem bulrush-common cattail), and one non-emergent riparian association, ***Bromus tectorum-Euthamia occidentalis*** association (downy brome-western goldenrod), were delineated (Appendix 4, Table 5). Diversity of the *Shore & Bottomland Wetland* cover type was very low (*H'*=0.9, Var(H')=0.6).

Scirpus acutus-Typha latifolia

Total vegetative cover averaged 17.2% (Table 8). Trees were absent and shrubs were rare. Average herbaceous cover was very low (16.3%). ***Scirpus acutus*** and ***T. latifolia*** share dominance although ***Scirpus acutus*** was more widespread among the transects. All remaining herbaceous species were rare. Most (67%) of the species encountered were native. The number of species per transect ranged from 2 to 17. Diversity was very low (H'=0.7, Var(H')=0.3) and the dominance of ***S. acutus*** and ***T. latifolia*** created a very uneven distribution of species (J=0.2).

Bromus tectorum-Euthamia occidentalis

Total vegetative cover averaged 24.9% (Table 8). High rock cover (48.1%) limited the potential for colonization of the shore wetlands included in this association. Trees were absent. Shrub cover was 3.4%. Herbaceous species dominated this association. None of the herbaceous species present were abundant. ***Bromus tectorum*** occurred widely, followed by ***Euthamia occidentalis***. The remaining species were uncommon, although several were widespread. Exotic species dominated, accounting for 60% of the species present. The number of species present ranged from 11 to 27. Diversity was low (H'=1.2, Var(H')=0.3). Species were unevenly distributed (J=0.3).

4.2.4. Scrub-Shrub Wetland Cover Type

Criteria for the *Scrub-Shrub Wetland* cover type included total cover greater than 30%, shrub cover equal to or greater than 30%, or tree and shrub cover less than 30% each when total woody cover exceeds 30% (Appendix 1). A total of 174 species composed the flora of this cover type. Average total cover was 98.6% (±27.5). Average tree cover was 5.3% (±7.4), shrub cover was 55.7% (±24.6), and herbaceous cover was 37.7% (±24.0). Three associations were identified (Appendix 5): ***Rhus trilobata-Rosa woodsii/Bromus tectorum*** association (squawbush-Wood's rose/downy brome), ***Salix exigua/Dipsacus fullonum/Solanum dulcamara*** association (coyote willow/teasel/deadly nightshade), and the ***Elaeagnus angustifolia-Salix exigua/Solanum dulcamara*** association (Russian olive-coyote willow/deadly nightshade) (Table 5).

Diversity of the *Scrub-Shrub Wetland* cover type was among the highest of all cover types sampled in the study area (*H'*=2.0, Var(H')=1.8).

Rhus trilobata-Rosa woodsii/Bromus tectorum

Total cover averaged 92.8% (Table 9). Trees were present in low abundance. The dominant tree species was ***Celtis reticulata*** (netleaf hackberry). Shrubs were clearly dominant (average cover = 67.7%). ***Rhus trilobata*** (squawbush) was the most abundant shrub followed by ***Rosa woodsii***, ***Salix exigua***, ***Ribes aureum*** (golden currant) and ***Toxicodendron radicans*** (poison ivy) (Table 9). The herbaceous understory was dominated by only a few species, none of which were abundant. The most frequently occurring herbaceous species was ***Bromus tectorum***. ***Dipsacus fullonum***, ***Melilotus alba*** and ***Solanum dulcamara*** were nearly as abundant, but not as widely distributed among transects as ***Bromus tectorum***. Fifty percent of the species present were native. The number of species per transect ranged from 5 to 29. Diversity was low (H'=1.6, Var(H')=0.5). The abundance of species was uneven (J=0.4).

Salix exigua/Dipsacus fullonum-Solanum dulcamara

Total cover averaged 91.4% (Table 9). Woody and herbaceous layers contributed equally to ground cover for this association. Trees were uncommon and ***Fraxinus pennsylvanica*** was the most frequently occurring tree species. ***Celtis reticulata*** and ***Salix*** spp. occurred occasionally. ***Salix exigua*** was the most abundant shrub species occurring in the association. ***Ribes aureum***, ***Toxicodendron radicans*** and ***Rhus trilobata*** occurred fairly frequently among transects, although average cover values tended to be low. The herbaceous understory was dominated by the exotic species ***Dipsacus fullonum*** and ***Solanum dulcamara***. ***Euthamia occidentalis*** and ***Apocynum cannabinum*** (dogbane), native herbs, also occurred frequently. Although low in abundance, ***Rumex crispus***, ***Bromus tectorum*** and ***Cirsium arvense*** were some of the most widespread herbaceous species present. The exotic vine, ***Solanum dulcamara***, occurred more widely than most forb species. Nearly one half (49%) of the species encountered were native. The number of species per transect ranged from 17 to 47. Diversity was moderate (H'=2.2, Var(H')=0.7) and species abundances were distributed evenly (J=0.5). This association generally occurred in unimpounded reaches of the study area: 11 of the 13 transects sampled were on the Wiley and Dike Reaches.

Elaeagnus angustifolia-Salix exigua/Solanum dulcamara

Total cover averaged 109.4% (Table 9). Shrubs dominated the association with 59.4% of the total cover. Trees were uncommon (average cover=6.3%). ***Salix*** spp. was the most dominant of the four tree species encountered. ***Elaeagnus angustifolia*** and ***Salix exigua*** shared dominance among shrub species. ***Elaeagnus angustifolia*** provided the greatest cover and ***S. exigua*** had a higher frequency of occurrence. Other shrubs occurring in the association included ***Rosa woodsii***, ***Rhus trilobata***, and ***Ribes aureum***. ***Dipsacus fullonum***, ***Chenopodium album***, ***Cirsium arvense***, ***Euthamia occidentalis***, and ***Lycopus asper*** were the most common herbaceous species encountered. ***Solanum dulcamara*** occurred more widely than any other species and was more abundant than any forbs. Over half (56%) of the herbaceous species encountered were native. The number of species per transect was ranged from 5 to 41. Diversity was moderate (H'=2.4, Var(H')=1.2). Because a number of species were dominant, evenness was moderate (J=0.5).

4.2.5. Forested Wetland Cover Type

The criteria for the *Forested Wetland* cover type were total cover greater than 30% and tree cover equal to or greater than 30% (Appendix 1). Trees are all woody species greater than 6 m tall. A total of 80 species composed the flora of this cover type. Average total cover was 122.3% (±27.7). Average tree cover was 58.0% (±18.3), shrub cover was 35.0% (±24.2), and herbaceous cover was 29.3% (±29.5). The *Forested Wetland* associations were among the most diverse encountered in the study area. Three riparian communities were delineated (Appendix 6): ***Salix*** spp./***Rosa woodsii***/***Solanum dulcamara*** association (willow (mixed species)/Wood's rose/deadly nightshade), ***Celtis reticulata***/***Rhus trilobata***/***Bromus tectorum*** association (netleaf hackberry/squawbush/downy brome), and ***Celtis reticulata***/***Bromus tectorum*** association (netleaf hackberry/downy brome) (Table 5). A fourth association, ***Betula occidentalis*** (water birch), was also found along the river, but was not sampled. A description of the ***Betula occidentalis*** association is provided in Appendix E.3.2-M. Overall, the *Forested Wetland* cover type had moderate diversity, although it was among the most diverse compared to other cover types present in the study area (*H'*= 1.8, Var(H')=0.6).

Salix **spp./*Rosa woodsii*/*Solanum dulcamara***

Total vegetative cover averaged 142.4% (Table 10). ***Salix*** tree species dominated this association. Other species of trees were encountered during sampling, all escaped ornamental species, but they were extremely rare in this association. ***Rosa woodsii*** was the most abundant shrub species followed by ***Toxicodendron radicans***, ***Salix exigua***, ***Elaeagnus angustifolia***, ***Rhus trilobata*** and ***Ribes aureum***. ***Solanum dulcamara*** was widespread and abundant. Among the multitude of herbaceous species that occurred, ***Dipsacus fullonum*** and ***Euthamia occidentalis*** were the most abundant. The number of species per transect ranged from 21 to 36. Less than half (47%) of the species sampled were native. Diversity was the highest of any of the associations described for the study area (H'=2.9, Var(H')=0.3). Species dominance was moderately even (J=0.7).

Celtis reticulata/Rhus trilobata/Bromus tectorum

Total vegetative cover averaged 110.3% (Table 10). The dominant tree species was ***Celtis reticulata***. Two other species of tree were encountered during sampling, both escaped ornamental species, but they were extremely rare in this association. The woody understory component was well developed. ***Rhus trilobata*** was the most common shrub, followed by ***Toxicodendron radicans*** and ***Ribes aureum***. Herbaceous cover was low (average cover was 10.1%) and dominated by ***Bromus tectorum***. Fifty-nine percent of the species encountered were native. The number of species per transect ranged from 11 to 15. Diversity was low (H'=1.6, Var(H')=0.2). Evenness was moderate (J=0.5).

Celtis reticulata/Bromus tectorum

Total vegetative cover averaged 94.4% (Table 10). ***Celtis reticulata*** was the only tree species encountered. The woody understory component was poorly developed. ***Ribes aureum*** was the only shrub species that occurred. Herbaceous cover was lowest of all three *Forested Wetland* associations (average cover was 3.4%) and was dominated by ***Bromus tectorum*** and ***Melilotus alba***. Only 43% of the species sampled were native. The number of species per transect was very low, ranging from 3 to 5. Subsequently, diversity was very low (H'=0.6, Var(H')=0.1) and evenness was very low (J=0.3).

4.2.6. Forested Upland Cover Type

Criterium for the *Forested Upland* cover type was tree cover greater than 25% for transects sampled in upland and riparian-to-upland transitional zones (Appendix 1). Only four transects met the criteria. A total of 31 species composed the flora of this cover type. Average total cover was 112.0% (±13.6). Average tree cover was 62.0% (±23.2), shrub cover was 30.5% (±23.6), and herbaceous cover was 19.5% (±22.3). Two transects were dominated by ***Celtis reticulata*** and two were dominated by ***Salix*** spp. Insufficient information was available to describe either of these possible associations.

4.2.7. Tree Savanna Cover Type

Criteria for the *Tree Savanna* cover type included total cover greater than 25%, tree cover more than 5%, but less than 25%, and tree cover greater than shrub cover (Appendix 1). Three transects met the definition of the cover type. Each transect was dominated by different vegetation, thus combining these into a single association was not appropriate. A total of 48 species composed the flora of this cover type. Average total cover was 55.5% (±28.3). Average tree cover was 14.1% (±4.5), shrub cover was 3.7% (±3.2), and herbaceous cover was 37.8% (±30.5).

4.2.8. Shrubland Cover Type

Criteria for the *Shrubland* cover type included shrub cover (woody species <5 m tall) equal to or greater than 25% and tree cover less than 25% (Appendix 1). A total of 122 species composed the flora of this cover type. Average total cover was 7.5% (±31.4). Average tree cover was 1.9% (±3.9), shrub cover was 58.8% (±24.9), and herbaceous cover was 26.9% (±26.9). One upland association and three riparian associations met the definition of this cover type (Appendix 7). The upland association was an ***Artemisia tridentata*/*Bromus tectorum*** association (big sagebrush/downy brome), and the three riparian associations included: ***Salix exigua-Rhus trilobata*/*Bromus tectorum*** association (coyote willow-squawbush/downy brome), ***Elaeagnus angustifolia*/*Chenopodium album*** association (Russian olive/lambsquarter), and ***Salix exigua/Melilotus alba*** association (coyote willow/white sweetclover) (Table 5). The *Shrubland* cover type appeared to have low diversity (*H'*=1.5, Var(H')=1.8).

Artemisia tridentata/Bromus tectorum

Total vegetative cover averaged 46.6% (Table 11). No tree species occurred on the transects sampled. ***Artemisia tridentata*** was the dominant shrub species. ***Chrysothamnus nauseosus***, ***Sarcobatus vermiculatus*** (greasewood), and ***Grayia spinosa*** (spiny hopsage) occurred occasionally. The understory was composed primarily of ***Bromus tectorum***. ***Poa secunda*** (Sandberg's bluegrass) was the most abundant native herbaceous species sampled. Most (61%) of the species encountered were native. The number of species per transect ranged from 4 to 14. Diversity was low (H'=0.9, Var(H')=0.2). This vegetation association was dominated by a few species (J=0.2).

Salix exigua-Rhus trilobata/Bromus tectorum

Total vegetative cover averaged 100.1% (Table 11). Tree cover occurred in 16% of all sample quadrats, but no species were dominant. ***Salix*** spp. trees were the most common trees, followed by ***Ulmus pumila*** (Siberian elm), and ***Morus alba*** (white mulberry). Nearly three-quarters of the cover was accounted for by shrubs. ***Salix exigua*** and ***Rhus trilobata*** co-dominated this association. Several other species of shrubs also occurred including ***Rosa woodsii***, ***Elaeagnus angustifolia***, ***Toxicodendron radicans*** and ***Ribes aureum***. Average cover of herbaceous species was low (19.2%). ***Bromus tectorum*** was the most frequently encountered herbaceous species followed by ***Glycyrrhiza lepidota*** and ***Dipsacus fullonum***. Native species composed 55% of the species encountered. The number of species occurring on each transect ranged from 6 to 20. Diversity was low (H'=1.6, Var(H')=0.6). Evenness was moderate (J=0.6).

Elaeagnus angustifolia/Chenopodium album

Total vegetative cover averaged 91.0% (Table 11). ***Elaeagnus angustifolia*** clearly dominated the shrub layer followed by ***Salix exigua*** and ***Rosa woodsii***. No trees were encountered during sampling. Herbaceous species accounted for 24.3% cover. The herbaceous species present were diverse, but individually, never abundant. None were common to every transect. ***Chenopodium album*** and ***Bromus tectorum*** were the most common herbaceous species present. ***Distichlis spicata*** (inland saltgrass) occurred frequently. Native species composed 57% of the flora encountered. The number of species per transect ranged from 2 to 16. Diversity was low (H'=1.3, Var(H')=0.4) and evenness was moderate (J=0.7).

Salix exigua/Melilotus alba

Total vegetative cover averaged 110.0% (Table 11). ***Salix exigua*** was the most dominant shrub species encountered. Other shrub species, including ***Elaeagnus angustifolia***, occurred at much lower frequency and cover. All together shrubs accounted for slightly less than one-half of the total cover. Trees were very rare (average cover=0.7%). Herbaceous species provided slightly higher coverage (59.7%) than shrubs (49.6%). ***Melilotus alba*** clearly dominated the herbaceous species, followed by ***Glycyrrhiza lepidota***, ***Euthamia occidentalis***, and ***Apocynum cannabinum***. ***Solanum dulcamara*** occurred frequently on the transects sampled. Native species make up about 54% of all species present. The number of species per transect ranged from 17 to 29. Diversity was moderate (H'=2.0, Var(H')=0.4). Species were distributed very unevenly (J=0.2).

4.2.9. Shrub Savanna Cover Type

Criteria for the *Shrub Savanna* cover type included total cover greater than 25%, shrubs (woody species < 5 m tall) more than 5% and less than 25% cover and shrub cover greater than tree cover (Appendix 1). A total of 138 species composed the flora of this cover type. Average total cover was 55.1% (±26.6). Average tree cover was 1.2% (±1.9), shrub cover was 15.6% (±4.9), and herbaceous cover was 38.4% (±26.5). Three riparian associations were delineated

(Appendix 8): mixed shrub/***Glycyrrhiza lepidota*** association (mixed shrub/Nuttall's licorice); ***Salix exigua***/***Melilotus alba*** association (coyote willow/white sweet clover); the ***Dipsacus fullonum***/mixed shrub (teasel/mixed shrub association) that combined traditionally riparian and upland vegetation; and two upland associations: ***Artemisia tridentata***/***Bromus tectorum*** association (big sagebrush/downy brome) and the ***Chrysothamnus nauseosus***/***Bromus tectorum*** association (gray rabbitbrush/downy brome) (Table 5). As a whole, the *Shrub Savanna* cover type had low diversity (*H'*= 1.4, Var(H')=2.2).

Mixed shrub/Glycyrrhiza lepidota

Total vegetative cover averaged 41.1% (Table 12). Tree species were rare. A number of shrub species were found at low abundances in this group. ***Toxicodendron radicans***, ***Rosa woodsii***, ***Artemisia ludoviciana*** (Louisiana sagebrush), ***Salix exigua***, ***Rhus trilobata***, and ***Ribes aureum*** occurred on 50% of the transects and each contributed 3% or less cover. Herbaceous species, especially ***Cirsium arvense*** and ***Glycyrrhiza lepidota***, were fairly abundant. ***Bromus tectorum*** occurred on every transect although at low cover. Fifty-nine percent of the species present were native. The number of species per transect ranged from 7 to 25. Diversity was low (H'=1.3, Var(H')=0.5) and dominance was shared by only a few species resulting in a low evenness (J=0.3).

Salix exigua/Melilotus alba

Total vegetative cover averaged 74.6%, most of it herbaceous (Table 12). Tree species were rare. The woody component was made up almost exclusively of ***Salix exigua***. The understory was strongly dominated by the weedy, exotic annual ***Melilotus alba***. The number of species per transect ranged from 11 to 23. Native species composed 33% of the flora. Diversity was low (H'=1.5, Var(H')=0.4) and dominance was shared by only a few species resulting in little evenness (J=0.4).

Dipsacus fullonum/Mixed shrub

Total vegetative cover averaged 88.6% (Table 12). This association encompassed vegetation occurring in the transitional zone between upland and riparian species. Only a small number of transects were classified into this association so the group was not well defined. Three tree species were encountered. Each had average cover values less than 1% and occurred only once. The dominant species in common among the transects that define the association were ***Chrysothamnus nauseosus***, ***Dipsacus fullonum***, ***Euthamia occidentalis***, ***Melilotus alba***, and ***Solanum dulcamara***. ***Elaeagnus angustifolia*** was the dominant shrub species on two transects; ***Purshia tridentata*** (antelope bitterbrush) was the dominant shrub on the remaining transect. Native species composed 52% of the species occurring in this association. The number of species per transect ranged from 30 to 43. Moderate diversity and evenness characterized this association (H'=2.46, Var(H')=0.41; J=0.67).

Artemisia tridentata/Bromus tectorum

Total vegetative cover averaged 53.7% (Table 12). ***Celtis reticulata*** was the only tree species that occurred on the transects sampled. ***Artemisia tridentata*** was the dominant shrub species with occasional occurrences of ***Chrysothamnus nauseosus***. ***Purshia tridentata***, ***Atriplex canescens*** (fourwing saltbush), ***Elaeagnus angustifolia***, ***Chrysothamnus nauseosus***, and ***Rhus trilobata*** occurred infrequently. Dead shrubs were a prominent part of the vegetation, providing over one-half the average cover of ***Artemisia tridentata***. The understory was composed almost entirely of exotic, annual herbs: ***Bromus tectorum***, ***Erodium cicutarium*** (crane's bill), and ***Sisymbrium altissimum*** (jim-hill mustard). ***Poa secunda*** was the most abundant native herb sampled. Sixty-four percent of the species encountered were native. The number of species per transect ranged from 8 to 15. Diversity was low (H'=1.2, Var(H')=0.3) and only a few species were dominant (J=0.3).

Chrysothamnus nauseosus/Bromus tectorum

Total vegetative cover averaged 38.4% (Table 12). Trees were absent. Six shrub species occurred in this association. Of the six, only two species were common. ***Chrysothamnus nauseosus*** was the most frequently occurring shrub species, followed by ***Chrysothamnus viscidiflorus*** (green rabbitbrush). ***Grayia spinosa*** (spiny hopsage) and ***Artemisia tridentata*** contributed to the diversity of shrubs in this association. Similar to the ***Artemisia tridentata***/***Bromus tectorum*** association, the understory was dominated by exotic annuals. ***Bromus tectorum*** and ***Sisymbrium altissimum*** were the most widespread and abundant species of the herbaceous component. ***Stipa comata*** (needle-and-thread grass), ***Poa secunda*** and ***Oryzopsis hymenoides*** (Indian ricegrass) were native bunchgrasses that were fairly common although low in abundance. Nearly 66% of the species present were native. Diversity was low (H'=1.0, Var(H')=0.4). A few species were dominant, thus evenness was low (J=0.3).

4.2.10. Forbland Cover Type

Criteria for the *Forbland* cover type included total cover equal to or greater than 25% and non-graminoid species dominate (Appendix 1). A total of 83 species composed the flora of this cover type. Average total cover was 71.0% (±27.1). Average tree cover was 0.2% (±0.9), shrub cover was 1.8% (±1.8), and herbaceous cover was 68.9% (±26.6). One riparian association was identified (Appendix 9): ***Melilotus alba-Dipsacus fullonum*** association (white sweetclover-teasel) (Table 5). One upland transect occurred in the *Forbland* cover type, therefore there was insufficient information to develop a description of the upland *Forbland* cover type. Although the Shannon-Weiner index of the *Forbland* cover type was low, it was intermediate among the cover types described in this text (H'= 1.6, Var(H')=0.8).

Melilotus alba-Dipsacus fullonum

Total vegetative cover averaged 73.4% (Table 13). Tree cover was virtually absent (average cover = 0.2%) and shrub species occurred infrequently (average cover = 2.2%). ***Melilotus alba*** and ***Dipsacus fullonum***, two exotic species, were the most abundant herbaceous species, followed by a native forb, ***Euthamia occidentalis***. Native species made up 68% of all species encountered. The number of species per transect ranged from 7 to 29. Diversity was low (H'=1.7, Var(H')=0.8). Because only three species were abundant, distribution of species was uneven (J=0.4).

4.2.11. Desertic Herbland Cover Type

Criteria for the *Desertic Herbland* cover type included total cover less than 25% and herbaceous cover must account for more than 50% of the total cover (Appendix 1). Data were analyzed for transects sampled in upland and riparian-to-upland transitional zones. A total of 48 species composed the flora of this cover type. Average total cover was 19.2% (±3.8). Tree cover was absent, shrub cover was 1.7% (±3.3), and herbaceous cover was 17.5% (±3.8).

Two associations were delineated (Appendix 10), however, one association was based only on two transects which is insufficient to provide an accurate description. The association that was distinguished was a ***Bromus tectorum-Sisymbrium altissimum*** association (downy brome/jim-hill mustard) (Table 5). The *Desertic Herbland* cover type was characterized by poor diversity (H'=0.8, Var(H')=0.4) and was among the lowest diversity indices reported for the cover types described for the Hagerman Study Area.

Bromus tectorum-Sisymbrium altissimum

Total cover averaged 19.6% (Table 14). Trees were absent and shrub species were very rare. All of the herbaceous species present had an average cover of less than 5%. ***Bromus tectorum*** was the most frequently occurring species, followed by ***Sisymbrium altissimum***. All remaining species occurred on one or two transects only. Most (64%) of the herbaceous species encountered were native. The number of species per transect from 7 to 12. Diversity was low (H'=0.8, Var(H') =0.2) and evenness was low (J=0.2).

5. Discussion

Riparian vegetation of the western United States typically forms narrow bands along stream courses in an otherwise arid environment (Malanson 1993, Mitsch and Gosselink 1993). This pattern is clearly established along the Snake River in the Hagerman Study Area (Figure 5) where only 12% of the landscape in the area delineated is riparian or wetland in nature.

Other patterns are apparent from the cover type map of the study area. The *Forested Wetlands* cover type demonstrated a marked distribution along the upstream portion, in the vicinity of Upper and Lower Salmon Falls Project Area (Table 4). The reasons for the distribution pattern have yet to be determined. Edaphic and topographic data have been collected by IPC in order to elucidate the parameters most likely responsible for the distribution of riparian and wetland plant species. The results of that study may be helpful in understanding the vegetation landscape patterns in the Hagerman Study Area.

Another cover type, *Shore & Bottomland Wetland*, shows a distinct distribution along the downstream portion of the study area in the vicinity of Bliss Reservoir and the Dike Reach (Table 4). In this portion, the aquatic system directly interfaces with the basalt parent material. Little deposition of fine sediments has occurred, therefore, vegetation establishment has been poor. The soils in the Bliss Project Area are well drained, stony (basalt ash) and fine sandy loams with low water holding capacity (Noe 1991). Limited lateral movement of moisture across the soil face results in extremely narrow wetted zones along the river margins and little opportunity for wetland and riparian development.

The vegetation cover types were classified into the numerous plant associations found in the study area. Twenty-six associations were classified by species dominance resulting in five emergent wetland, 17 riparian and four upland associations. ***Salix exigua*** occurs as a significant component in 65% of the riparian and emergent wetland associations. Almost half of those associations were dominated by ***Salix exigua***. ***Salix exigua*** is commonly dominant in the riparian vegetation of the Intermountain Region. The dominance is related in part to the highly competitive, colonial nature of the species (Goodrich 1992). Being shade intolerant, ***Salix exigua*** is highly adapted to most forms of disturbance, especially repeated fluvial disturbance (Hansen 1992). In upland associations, ***Bromus tectorum*** was the most common understory species suggesting a history of disturbance (Mack 1989), and the possible spread into adjacent, undisturbed areas as well (Heywood 1989).

Within the middle Snake classification there are associations that are similar in composition but have been classified into separate communities because of differences in lifeform abundances, e.g., the ***Artemisia tridentata/Bromus tectorum*** upland associations found in the *Shrubland* and *Shrub Savanna* cover types. By definition the former has greater shrub cover, but the latter had more shrub species present that respond positively after disturbances (***Chrysothamnus nauseosus*** and ***C. viscidiflorus***). In addition, the *Shrub Savanna* association has a prominent coverage of standing dead shrubs. Another principal difference between the two associations is the abundance of annual, exotic weeds in the understory of the *Shrub Savanna* plant association. The abundance of annual weeds and disturbance-tolerant shrubs, coupled with the abundance of dead, standing shrubs suggested the *Shrub Savanna* association may be a more severely or more recently disturbed form of the *Shrubland* plant association.

Two plant associations described in this report appear to be similar to others reported by Huschle (1975) for the Hells Canyon of the Snake River. The ***Elaeagnus angustifolia-Chenopodium album*** associations in the Hells Canyon and the Hagerman Study Area were similar in the abundance of the common species, but the association in the Hagerman Study Area was more diverse. Furthermore, ***Bromus tectorum*** was absent from the Hells Canyon association. The upland plant association, ***Chrysothamnus nauseosus/Bromus tectorum***, of the Hagerman Study Area appeared to be equivalent to the ***Chrysothamnus nauseosus/Bromus tectorum*** community of Hells Canyon. Like many of the associations of the *Shrub Savanna* cover type, the ***Chrysothamnus nauseosus/Bromus tectorum*** association appeared to be disturbed. The low abundance of ***Artemisia tridentata***, the high frequency of occurrence of ***C. nauseosus*** and the presence of several species of native bunchgrass suggested that the principal source of disturbance has been fire. ***Chrysothamnus*** spp., ***Poa secunda***, ***Oryzopsis hymenoides*** and ***Stipa comata*** are known to resprout after fire while ***Artemisia tridentata*** typically is killed by fire (Daubenmire 1968).

Natural disturbances can influence the composition and abundance of native vegetation. For example, the frequent occurrence of two upland species, ***Artemisia tridentata*** and ***Chrysothamnus nauseosus***, within the riparian zone may have resulted from the drought conditions experienced prior to and during the study period. Neither species is flood tolerant. The unusually dry climatic conditions that occurred during the study period reduced the opportunity for floods that would have killed the upland species growing within the flood zone.

The Palmer Drought Severity Index (PDSI) can be used to demonstrate the development of drought conditions during the study period (Figure 6). The PSDI is a standardized technique used to monitor drought and moisture periods (A. Gorsky, National Weather Service, Boise, ID, *pers. comm.)* The index is based on long term climatic data, soil moisture characteristics, potential evaporation estimates, runoff, and precipitation estimates for a particular region (Denny and Heddinghaus 1987). Although limited by the complexity of modeling the onset, intensity and duration of drought conditions (Allen 1984), the strength of the index lies in its integration of data preceding and following the date represented by the index, i.e., the index is calculated after the date is past (A. Gorsky, National Weather Service, Boise, ID, *pers. comm.*).

Natural drought cycles can heavily influence productivity of the sagebrush-bunchgrass ecosystem. Numerous reports from the 1930's link lower productivity in pasture lands and shrublands with drought conditions (see review in Blaisdell 1958). Blaisdell’s own studies (1958) suggested that herbage production in sagebrush-grass vegetation was significantly, negatively affected by decreased precipitation. Precipitation from early spring storm events appeared to be of particular importance in determining yield and flowering effort. Similar relationships between drought and production and timing of precipitation events were seen for ***Atriplex confertifolia*** (shadscale) communities in south-central Idaho (Sharp et al. 1990). Production was reduced and invasion by weedy exotic species and natural insect pests was enhanced. Drought conditions have prevailed in the Hagerman Study Area since 1986 (Figure 6) and cover and survival of individuals in the upland vegetation has undoubtedly been reduced. Effects in riparian and emergent vegetation are expected to be minimized, except in the transitional zone between riparian and upland vegetation, because of the presence of water at or near the soil surface.

Diversity in shrub steppe vegetation is generally moderate (West 1983*b)*. In the study area diversity indices were low in upland vegetation associations. Margalef (1972) suggests the lower range of values for the Shannon-Wiener Diversity Index is approximately 1.0. Values in upland vegetation studied in the Hagerman Study Area cluster around 1.0 (range 0.6 - 1.2). Evenness tended to be low (range 0.2 - 0.3), and characteristic of communities with very few dominant species (Franklin and Dyrness 1988). Diversity is related to the ecological state of vegetation communities in several ways. Successional status and time since disturbance can increase or decrease diversity depending on colonization rates (Peet 1992) and grazing of vegetation that is not adapted to the presence of herds of large, hooved animals can reduce diversity (West 1993, Mack 1989).

There is less information available about the composition and structure of native, undisturbed riparian and emergent communities of western rivers than is available for the upland vegetation surrounding them. Except for the sparsely vegetated *Shore* & *Bottomland Wetland* associations, riparian associations had higher diversity indices (range 1.3 - 2.9) than did upland associations. Dominance among species was also more evenly distributed in riparian associations (range 0.2 - 0.7). Western riparian vegetation is generally accepted to be more diverse than surrounding vegetation (Mitsch and Gosselink 1993).

All of the plant associations described have exotic species as an integral component of their composition. In some instances (e.g., ***Artemisia tridentata/Bromus tectorum***, ***Salix exigua/Dipsacus fullonum-Solanum dulcamara*** and ***Elaeagnus angustifolia/Chenopodium album*** plant associations), exotics are part or all of the dominance structure of the association. Invasions of weedy species are primarily, although not exclusively, promulgated by disturbance (Heywood 1989). The number and duration of anthropomorphic disturbances that have occurred within and outside of the study area, including waterfront development, grazing, farming, water removal and seasonal shifts in distribution of water, have undoubtedly enhanced the opportunity for establishment of exotic species into the natural vegetation communities of the study area.

Invasions can also occur in ‘undisturbed’ communities, but the event is uncommon and not well understood. The invasion simply may be related to the quantity of propagules available for transportation from disturbed areas into undisturbed areas (Rejmanek 1989). Therefore, proximity to disturbed areas may increase the likelihood of invasion, especially if natural disturbance, e.g., rodent digging, has created open spaces in the undisturbed area.

The abundance of ***Bromus tectorum*** in the study area suggests that enhanced fire hazards and the potential loss of native shrub-dominated communities is likely. Fire history data are available for the period 1979-1990 from B.L.M. records (Boise District Office, B.L.M., Boise, ID). In the vicinity of the Hagerman Study Area, 21 fires burned over 117,400 ha during the 10 year period of record (Table 15). During that time, 37% of the burned acreage burned again at least twice, resulting in areas with a minimum, short-term fire frequency of every 10 years, a far shorter period than the 17 to 70 year interval described in the literature (Houston 1973, Young and Evans 1978, Wright et al. 1979).

Generally, cessation of disturbance is followed by a reestablishment, through normal successional processes, of climax vegetation. Some exotic species, like ***Bromus tectorum***, have invaded disturbed areas and persisted. In effect, these species have altered normal successional patterns to the extent that reestablishment of climax vegetation is virtually impossible without human intervention (Franklin and Dyrness 1988).

The organization of plant communities across landscapes has been studied intensively for almost a century. A number of hypotheses that explain patterns and processes of organization have been expressed. Two theories dominated discussions in North America early in the 1900's, the individualistic hypothesis (Gleason 1926), where species assemblages are made up of species specifically adapted to local conditions, and the Clementsian hypothesis (Clements 1916) in which species assemblages are constant and function as an 'organism' having evolved with a similar evolutionary history (Miles 1979) and generally with a specific climax assemblage (Clements 1928). Two hypotheses concerning community organization developed in Europe at about the same time. Braun-Blanquet proposed that assemblages possessed properties that permitted classification of assemblages into orderly systems of communities much like the taxonomy of species is ordered (Mueller-Dombois 1988). The term 'ecosystem' was coined by Tansley in 1935 in his discussion of the relationship of environment to species distributions and consequent assemblages (Mueller-Dombois 1988). Tansley felt that the relationship was so strong that studying the integration of species within ecosystems was the key to understanding patterns and process in vegetation. Numerous modifications of the hypotheses have been proposed over the years and no single hypothesis has been satisfactory.

Commonly, classification of vegetation is done with the intent to understand successional patterns in communities (Johnson and Simon 1987) and to aid in the development of management strategies for particular vegetation types. Typically, analysis of successional relationships includes identification of site factors (e.g., topography, edaphic characteristics) shared in common among plant associations with similar species compositions, and the establishment of a successional series that is based on increasing community productivity, stature and soil maturity (Shimwell 1971). Successional relationships are difficult to discern among associations where weedy species form a significant portion of the species abundance. Hironaka et al. (1983) believed the climax community of the uplands occurring in the Hagerman Study Area fell into the ***Artemisia tridentata*** ssp. ***Wyomingensis***/***Stipa thurberiana*** habitat type. Hironaka and his coworkers considered the classification of sagebrush types as tentative because it was difficult to find examples of pristine sagebrush vegetation. Under moderate and severe disturbance regimes the ***Stipa thurberiana*** is lost and ***Poa secunda*** becomes the dominant understory species. The sagebrush-grass associations described in this report do not bear much resemblance to the community described by Hironaka et al. If Hironaka's group is correct, the sagebrush vegetation of the Hagerman Study Area is so disturbed that the habitat type no longer occurs.

Without information on the physical environment, the development of a successional series is preliminary at best. Guided only by vegetative characteristics, it is possible to describe what relationships may exist for one pair of emergent wetland associations. The ***Scirpus acutus*-*Lemna*** sp. plant association has ***Solanum dulcamara*** present at low cover, but wide distribution across transects. A second association, ***Scirpus acutus*-*Lemna*** sp.-***Solanum dulcamara***, was characterized by the same dominant species and widespread distribution of ***Solanum dulcamara***, but ***Solanum dulcamara*** was more prominent. Because the second association had greater cover and slightly higher number of species represented, it may be a more mature expression of the ***Scirpus acutus*-*Lemna*** sp. association.

While general patterns can be discerned at the landscape level there is enough variation in species distributions to limit the wide application of any classification scheme. However, the value of classifying vegetation into ecologically similar units has value for land managers concerned about resource utilization.

6. Conclusions

A total of 27 vegetation, natural feature and land use cover types were found in the Hagerman Study Area. Aquatic habitats, including the river and nearby ponds, accounted for 14.8% of the total area. Land use cover types, dominated by agriculture and grazed pastures, occupied 21.6% of the total area, and vegetation cover types accounted for the remainder (54.3%) (Table 3). Wetland/riparian vegetation cover types account for 6.8% of the total area and only 12% of the area occupied by vegetation cover types. Upland vegetation cover types account for 88% of the area occupied by vegetation cover types. *Lotic*, *Shrubland* and *Shrub Savanna* cover types were the most abundant of the cover types present (Table 3). *Shore & Bottomland Wetland* and *Forested Wetland* cover types were associated with specific reaches of the study area. Riparian and emergent wetland cover types were proportionally less common in the Bliss Project Area than elsewhere in the study area.

A total of 26 plant associations were classified from data representing the vegetation cover types. Five vegetation associations were defined for the *Shrub Savanna* cover type, four associations were defined for the *Emergent Herbaceous Wetland* and *Shrubland* cover types, three associations were found in the *Non-Emergent Herbaceous Wetland*, *Scrub-Shrub Wetland* and *Forested Wetland* cover types, two associations were found in the *Shore & Bottomland Wetland* cover type and one association was delineated from the *Forbland* and *Desertic Herbland* cover types, respectively. Three cover types were sampled insufficiently to permit classification of data into vegetation associations. All of the associations have exotic species representing a significant portion of total cover; some are dominated by exotic species. Two associations are similar to associations found downstream in Hells Canyon.

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8. Literature Cited

Anderson, J. E. and K. E. Holte. 1981. Vegetation development over 25 years without grazing on sagebrush-dominated rangeland in southeastern Idaho. J. Range Manage. 34(1):25-29.

Alley, W. M. 1984. The Palmer Drought Severity Index: limitations and assumptions. J. Climate and Appl. Meteorol. 23:1100-1109.

Bailey, R. G. 1978. Descriptions of the ecoregions of the United States. U.S.D.A.-For. Serv. Ogden, Ut. 77pp.

Blaisdell, J. P. 1958. Seasonal development and yield of native plants on the Upper Snake River Plains and their relation to certain climatic factors. U.S. Dep. Agric. Tech. Bull. No. 1190. 63pp.

Bowler, P. A. 1981. Natural history studies and an evaluation for eligibility of the Wiley Reach of the Snake River for National Natural Landmark Designation. Univ. Calif., Irvine, Calif.; 86pp.

Caldwell, M. M. 1985. Cold desert. Pages 108-212 *in* B. F. Chabot and H. A. Mooney, eds. Physiological ecology of North American plant communities. Chapman and Hall, New York.

Clements, F. E. 1916. Plant succession. An analysis of the development of vegetation. Carnegie Instit., Washington, D.C.

Clements, F. E. 1928. Plant succession and indicators. H. W. Wilson Co., New York.

Clements, F. E. and E. S. Clements. 1939. The sagebrush disclimax. Carnegie Instit. Wash. Yearbook 38:139-140.

Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S.D.I.-U.S. Fish and Wildl. Serv., FWS/OBS-79/31, Washington D.C. 131pp.

Daubenmire, R. F. 1959. Canopy coverage method of vegetation analysis. Northwest Sci. 33:43-64.

Daubenmire, R. F. 1968. Ecology of fire in grasslands. Adv. Ecol. Res. 5:207-266.

Daubenmire, R. F. 1970. Steppe vegetation of Washington. Wash. Agric. Exp. Stn. Tech. Bull. 62. 131pp.

Denny, L. M. and T. R. Heddinghaus. 1987. The Severity (long term, Palmer) Index. *Weekly Weather and Crop Bull*. 21 April, 4.

Etherington, J. R. 1983. Wetland ecology. Studies in Biology No. 154. Edward Arnold Publ. Ltd, London. 66pp.

Floyd, D. and J. E. Anderson. 1982. A new point interception frame for estimating cover of vegetation. Vegetatio 50:185-186.

Franklin, J. F. and C. T. Dyrness. 1988. Natural vegetation of Oregon and Washington. Oregon State Univ. Press, Corvallis. 452pp.

Fremont, J. C. 1845. Report of the exploring expedition to the Rocky Mountains in the year 1842 and to Oregon and north California in the years 1843-44. Gales and Seaton, Printers, Washington, D.C.

Gauch, Jr., H. G. 1982. Multivariate analysis in community ecology. Cambridge Stud. in Ecol. Cambridge Univ. Press, Cambridge.

Gleason, H. A. 1926. The individualistic concept of the plant association. Bull. Torrey Bot. Club 53:7-26.

Goodrich, S. 1992. Summary flora of riparian shrub communities of the Intermountain Region with emphasis on willows. Pages 62-67 *in* W. P. Clary, E. D. McArthur, D. Bedunah and C. L. Wambolt, eds. Proceedings--Symposium on ecology and management of riparian shrub communities, May 29-31, 1991, Sun Valley, Id. U.S.For. Ser. Intermountain Res. Stn. Gen. Tech. Rep. INT-289.

Greenwood, A. P. 1987. We sagebrush folks. Univ. of Id. Press, Moscow. 489pp.

Hansen, P. L. 1992. Classification and management of riparian-wetland shrub sites in Montana. Pages 68-78 *in* W. P. Clary, E. D. McArthur, D. Bedunah and C. L. Wambolt, eds. Proceedings--Symposium on ecology and management of riparian shrub communities, May 29-31, 1991, Sun Valley, Id. U.S. For. Ser. Intermt. Res. Stn. Gen. Tech. Rep. INT-289.

Heywood, V. H. 1989. Patterns, extents and modes of invasions by terrestrial plants. Pages 31-60 *in* Drake, J. A., H. A. Mooney, F. di Castri, R. H. Groves, F. J. Kruger, M. Rejmánek and M. Williamson, eds. Biological invasions, a global perspective. Scientific Committee on Problems of the Environment 37. John Wiley and Sons, New York.

Hidy, G. M. and H. E. Klieforth. 1990. Atmospheric processes affecting the climate of the Great Basin. Pages 17-45 *in* C. B. Osmond, L. F. Pitelka and G. M. Hidy, eds. Plant biology of the basin and range. Springer-Verlag, New York.

Hironaka, M., M. A. Fosberg and A. H. Winward. 1983. Sagebrush-grass habitat types of southern Idaho. For., Wildl. and Range Exp. Stn. Bull. No. 35. Univ. of Id., Moscow. 44pp.

Houston, D. B. 1973. Wildfires in northern Yellowstone National Park. Ecology 54:1111-1117.

Huschle, G. 1975. Analysis of the vegetation along the middle and lower Snake River. M.S. Thesis. Univ. of Id., Moscow. 265pp.

Hutchinson, D. J. and L. R. Jones. 1989. Emigrant trails of southern Idaho. Id. Cult. Resour. Ser. No. 1., Bur. of Land Manage. 233pp.

Idaho Power Company. 1979. A. J. Wiley Hydroelectric Project, Application for License, Exhibit W-Environmental Report. Id. Power Co., Boise.

Jensen, D. and L. Verhovek. 1979. Studies of water use on the Snake River, southern Idaho: vegetation analysis. Univ. of Calif., Irvine.

Johgman, R. H. G., C. J. F. ter Braak and O. F. R. van Tongeren, eds. 1987. Data analysis in community and landscape ecology. Pudoc, Wageningen, The Netherlands.

Johnson Jr., C. G and S. A. Simon. 1987. Plant associations of the Wallowa-Snake Province. U.S. For. Serv., Pacific Northwest Reg. R6/ECOL-TP-255B-86.

Johnson, W. C., M. Dixon, G. Larson and R. Simons. 1992. Riparian vegetation along the Snake River, Idaho, below Swan Falls Dam: past, present and future. Final Report to Idaho Power Co., Boise Id. 85 pp. plus tables, figs. and append.

Kartesz, J. T. and R. Kartesz. 1980. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. Vol. II. The biota of North America. Univ. N. Carolina Press, Chapel Hill. 498pp.

Kent, M. and P. Coker. 1992. Vegetation description and analysis, a practical approach. CRC Press, Boca Raton, Fl. 363pp.

Klimas, C. V. 1988. River regulation effects on floodplain hydrology and ecology. Pages 40-49 *in* D. D. Hook, W. H. McKee, Jr., H. K. Smith, J. Gregory, V. G. Burrell, Jr., M. R. DeVoe, R. E. Sojba, S. Gilbert, R. Banks, L. H. Stolzy, C.Brooks, T. D. Matthews and T. H. Shear, eds. The ecology and management of wetlands, Vol. 1, Timber Press, Portland, Oreg.

Lenz, L. W. 1986. Marcus E. Jones, western geologist, mining engineer and botanist. Rancho Santa Ana Botanic Garden. Claremont, Ca. 330pp.

Mack, R. N. 1989. Temperate grasslands vulnerable to plant invasions: characteristics and consequences. Pages 155-180 *in* J. A. Drake, H. A. Mooney, F. di Castri, R. H. Groves, F. J. Kruger, M. Rejmanek and M. Williamson, eds. Biological invasions, a global perspective. Scientific Committee on Problems of the Environment 37. John Wiley & Sons, New York.

Mack, R. N. 1986. Alien plant invasion into the Intermountain West: a case history. Pages 191-213 *in* H. A. Mooney and J. A. Drake, eds. Ecology of biological invasions of North America and Hawaii. Springer-Verlag, New York.

Mack, R. N. and J. N. Thompson. 1982. Evolution in steppe with few large, hooved mammals. Am. Nat. 119:757-773.

Magurran, A. E. 1988. Ecological diversity and its measurement. Princeton Univ. Press, Princeton, N. J. 179pp.

Malanson, G.P. 1993. Riparian landscapes. Cambridge Stud. in Ecol. 296pp.

Marble, J. R. and K. T. Harper. 1989. Effect of timing of grazing on soil-surface cryptogamic communities in a Great Basin low-shrub desert: a preliminary report. Great Basin Nat. 49(1):104-107.

Margalef, R. 1972. Homage to Evelyn Hutchinson, or why is there an upper limit to diversity. Trans. Conn. Acad. Arts Sci. 44:211-235.

Minshall, G. W., S. E. Jensen and W. S. Platts. 1989. The ecology of stream and riparian habitats of the Great Basin Region: a community profile. U.S. Fish and Wildl. Serv., Environ. Prot. Agency Biol. Rep. 85(7.24). 143pp.

Miles, J. 1979. Vegetation dynamics. Outline studies in ecology. Chapman and Hall, London. 80pp.

Miss, C. J. and S. K. Campbell. 1988. Cultural resources survey for the A. J. Wiley hydroelectric project. Report No. 88-3, Northwest Archaeological Assoc., Inc. Seattle, Wash. 67pp.

Mitsch, W. J. and J. G. Gosselink. 1988. Wetlands. Van Nostrand/Reinhold Publ., New York. 539pp.

Mitsch. W. J. and J. G. Gosselink. 1993. Wetlands. Second ed. Van Nostrand/Reinhold Publ., New York. 539pp.

Mueller-Dombois, D. 1988. Community organization and ecosystem theory. Can. J. Bot. 66(12):2620-2625.

Myhre, J. and A. Clements. 1972. A study of the flora of the islands and the shorelines of the Snake River between Grandview, Idaho, and Guffey Butte, Owyhee County, Idaho. Snake River Reg. Stud. Cent., Coll. of Id., Caldwell. 23pp.

Noe, H. R. 1991. Soil survey of Elmore County area, Idaho, parts of Elmore, Owyhee, and Ada Counties. Soil Conser. Serv. 500pp. plus 236 figs.

Ostrogorsky, M. 1981. Archaeological investigations at historic sites in the Snake River Canyon near Bliss, Idaho. Proj. Rep., No. 6. Idaho Archaeological Consultants, Boise. 129pp., plus append.

Padgett, W. G., A. H. Winward and A. P. Youngblood. 1987. Classification of riparian communities in the Intermountain Region. Pages 101-106 *in* K. M. Mutz and L. C. Lee, tech. coord. Proc. Soc. Wetl. Sci. Eighth Annu. Meeting. Seattle, Wash.

Peet, R. K. 1992. Community structure and ecosystem function. Pages 103-151 *in* D. L. Glenn-Lewin, R K. Peet and T. T. Veblen, eds. Plant succession, theory and prediction. Population and community biology series 11. Chapman & Hall, New York.

Pielou, E. C. 1969. An introduction to mathematical ecology. Wiley-Interscience, New York.

Reed Jr., P. B. 1988. National list of plant species that occur in wetlands: Northwest (Region 9) 1988. Biol. Rep. 88 (24), U.S. Fish and Wildl. Serv., Army-Corps of Eng., Environ. Prot. Agency, Soil Conserv. Serv. 39pp.

Rejmanek, M. 1989. Invasibility of plant communities. Pages 369-388 *in* J. A. Drake, H. A. Mooney, F. di Castri, R. H. Groves, F. J. Kruger, and M. Williamson, eds. Biological invasions, a global perspective. Scientific Committee on Problems of the Environment 37. John Wiley & Sons, New York.

Sather-Blair, S. 1988. Western riparian wetland losses and degradation: status and trends. Influence of federal water and private hydroelectric projects. U.S. Fish and Wildl. Serv., Boise, Id. Draft, unpublished report.

Scott, J. M., B. Csuti, J. D. Jacobi, and J. E. Estes. 1987. Species richness, a geographic approach to protecting future biological diversity. BioScience 37(11):782-788.

Settle, R. W. 1940. The march of the mounted rifleman. First United States military expedition to travel the full length of the Oregon Trail from Fort Leavenworth to Fort Vancouver, May to October, 1849. The Arthur Clark Co. Glendale, Calif. 380pp.

Shannon, C. E. and W. Weaver. 1949. The mathematematical theory of communication. Univ. of Ill. Press, Urbana.

Shantz, H. L. and R. Zon. 1924. Atlas of american agriculture. Part 1. The physical basis of agriculture. Sec. E. Natural vegetation, Bur. Agric. Econ., Washington, D.C.

Sharp, L. A., K. Sanders, and N. Rimbey. 1990. Forty years of change in a shadscale stand in Idaho. Rangelands 12(6):313-328.

Shimwell, D. W. 1971. The description and classification of vegetation. Univ. of Wash. Press, Seattle. 322pp.

Soil Conservation Service. 1980. Idaho Plant List, Section I. Soil Conservation Service, Boise, Id. 69pp.

Stacy, S. M. 1991. Legacy of light: a history of Idaho Power Company. Id. Power Co., Boise. 256pp.

Szaro, R. C. 1989. Riparian forest and scrubland community types of Arizona and New Mexico. Desert Plants 9(3-4):1-138.

Tisdale, E. W. 1986. Native vegetation of Idaho. Rangelands 8(5):202-207.

Tisdale, E. W. and M. Hironaka. 1981. The sagebrush-grass region: a review of the ecological literature. For., Wildl. and Range Exp. Stn. Bull. Contribution No. 209. Univ. of Id., Moscow. 31pp.

Townsend, J. K. 1905. Narrative of a journey across the Rocky Mountains to the Columbia Basin. Pages 112-369 *in* R. G. Thwaites, ed. 1905. Early western travels. Vol. XXI-Wyeth, Townsend. Arthur H. Clark Co., Cleveland, Oh.

U.S. Fish and Wildlife Service. 1981. Habitat Evaluation Procedure. Ecological Services Manual 102. Washington, D.C.

Weaver, J. E. and F. E. Clements. 1938. Plant ecology. McGraw Hill, New York. 601pp.

West, N. E. 1993. Biodiversity of rangelands. J. Range Manage. 46:2-13.

West, N. E. 1988. Intermountain deserts, shrub steppes, and woodlands. Pages 209-230 *in* M. G. Barbour and W. D. Billings, eds. North American terrestrial vegetation. Cambridge Univ. Press, Cambridge.

West, N. E. 1983*a*. Overview of North American temperate deserts and semi-deserts. Pages 321-330 *in* N. E. West, ed. Ecosystems of the world 5. Temperate deserts and semi-deserts. Elsevier Sci. Publ. Co., New York.

West, N. E. 1983*b*. Western Intermountain sagebrush steppe. Pages 351-374 *in* N. E. West, ed. Ecosystems of the world 5. Temperate deserts and semi-deserts. Elsevier Sci. Publ. Co., New York.

Whisenant, S. G. 1990. Changing fire frequencies on Idaho's Snake River Plains: ecological and management implications. Pages 4-10 *in* E. D. McArthur, E. M. Romney, S. T. Smith, and P. T. Tueller, eds. Proceedings--Symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management. U.S. For. Serv., Intermt. Res. Stn. Gen. Tech. Rep., INT-276.

Wright, H. A., L. F. Neuenschwander and C. M. Britton. 1979. The role and use of fire in sagebrush-grass and pinyon-juniper communities: a state-of-the-art review. U.S., For. Serv. Gen. Tech. Rep., INT-58. 48pp.

Yensen, D. 1982. A grazing history of southwestern Idaho with emphasis on the Birds of Prey Study Area. Bur. Land. Manage. 82pp.

Young, J. A. And R. A. Evans. 1978. Population dynamics after wildfires in sagebrush grasslands. J. Range Manage. 31(4):283-289.

Young, J. A., R. A. Evans and P. T. Tueller. 1976. Great Basin plant communities--pristine and grazed. Pages 186-215 *in* R. Elston, ed. Holocene environmental change in the Great Basin. Nevada Archeol. Surv. Res. Pap. No. 6., Nevada State Museum, Reno.

Young, J. A. 1986. Snake River Country--a rangeland heritage. Rangelands 8:199-207.

Table 1. Wetland coverage in the Hagerman Study Area. Based on the U. S.F.W.S. National Wetlands Inventory maps for the Hagerman Study Area. Data are the sum of mapped polygons for each cover type plus the sum of linear features multiplied by the average width of each cover type (IPC, unpublished data).

Cover type	Area (ha)	% of total
Lacustrine, limnetic	8.5	1.3
Lacustrine, littoral	46.3	7.0
Palustrine, aquatic beds	24.1	3.7
Palustrine, emergent	169.0	25.6
Palustrine, forested	41.8	6.3
Palustrine, rocky bottom	0.3	<0.1
Palustrine, scrub shrub	177.6	26.9
unconsolidated bottom	71.2	10.8
Palustrine, unconsolidated shore	8.7	1.3
Riverine, upper perennial	49.7	7.5
Riverine, intermittent	62.7	9.5
Total hectares:	659.9	

Table 2. Land use/land cover types for the Hagerman Study Area, 1989. Wetland cover types generally follow the classification system described by Cowardin et al. (1979) and modified for Habitat Evaluation Procedures (HEP) (U.S.F.W.S. 1981). Upland cover types generally follow the classification system used for HEP cover types as outlined in U.S.F.W.S. (1981). Numbers refer to definitions found in Appendix 1.

No.	Cover Type	No.	Cover Type
1	Emergent Herbaceous Wetland	16	Forbland
2	Non-Emergent Herbaceous Wetland	17	Barrenland
3	Shore & Bottomland Wetland	18	Slope
4	Scrub-Shrub Wetland	19	Disturbed
5	Forested Wetland	20	Agriculture (Cultivated)
6	Lentic	21	Grazing Land/Pasture
7	Lotic	22	Urban
8	Forested Upland	23	Residential
9	Shrubland	24	Industrial
10	Tree Savanna	25	Parks/Recreation
11	Shrub Savanna	26	Roads
12	Desertic Woodland	27	Forested/Orchard
13	Desertic Shrubland		
14	Desertic Herbland		
15	Grassland		

Table 3. Cover types identified on a vegetation/land use cover type map of the Hagerman Study Area based on aerial photographs taken in 1989. Vegetation and land use classifications were defined by Habitat Evaluation Procedures (U.S.F.W.S. 1981). The *Non-Emergent Herbaceous Wetland* cover type was created by IPC.

Cover type	ha	% of total
Vegetation	3394.4	54.3
Emergent Herbaceous Wetland	28.6	0.5
Non-Emergent Herbaceous Wetland	64.2	1.0
Shore & Bottomland Wetland	4.2	0.1
Scrub-Shrub Wetland	271.0	4.3
Forested Wetland	54.6	0.9
Forested Upland	3.4	0.1
Shrubland	1770.8	28.3
Tree Savanna	6.8	0.1
Shrub Savanna	553.5	8.9
Desertic Woodland	4.7	0.1
Desertic Shrubland	259.3	4.1
Desertic Herbland	8.5	0.1
Grassland	305.8	4.9
Forbland	59.0	0.9
Natural features	1017.4	16.3
Barrenland	28.6	0.5
Cliff/Talus slope	62.9	1.0
Lentic	40.9	0.7
	885.0	14.1
Land use	1347.0	21.6
Disturbed	125.3	2.0
Agriculture	500.7	8.0
Grazing Land/Pasture	481.4	7.7
Urban	6.9	0.1
Residential	71.0	1.1
Industrial	62.3	1.0
Park/Recreation	7.5	0.1
Roads	78.5	1.3
Forested/Orchard	13.4	0.2

Table 3. (Continued)

Cover type	ha	% of total
Total area typed	5758.8	
Untyped region of 500m buffer	491.3	7.9
Total area	6250.1	100

Upper Salmon Falls | Lower Salmon Falls | Bliss
project area | project boundary | study area | project area | project boundary | study area | project area | project boundary | study area
Cover type | ha | % | ha | % | % | ha | % | ha | % | % | ha | % | ha | % | %

Table 4. Cover types identified within the project area and project boundaries of the three hydroelectric projects in the Hagerman Study Area based on aerial photographs taken in 1989. Vegetation and land use classification was based on Habitat Evaluation Procedures (U.S.F.W.S. 1981). The *Non-Emergent Herbaceous Wetland* cover type was created by IPC.

	Upper Salmon Falls					Lower Salmon Falls					Bliss				
	project area		project boundary		study area	project area		project boundary		study area	project area		project boundary		study area
Cover type	ha	%	ha	%	%	ha	%	ha	%	%	ha	%	ha	%	%
Vegetation															
Emergent Herbaceous Wetland	8.9	1.1	1.1	0.8	<0.1	6.5	0.6	4.3	1.2	0.1	0.2	<0.1	0.6	0.3	<0.1
Non-Emergent Herbaceous Wetland	4.5	0.5	2.4	1.6	<0.1	19.2	1.8	3.4	0.9	0.1	8.5	1.0	1.9	1.1	<0.1
Shore & Bottomland Wetland	0		0	0	0	<0.1	<0.1	0	0	0	0		0.8	0.5	<0.1
Scrub-Shrub Wetland	69.2	8.2	16.7	11.3	0.3	45.4	4.2	13.8	3.8	0.2	14.9	1.7	4.2	2.4	0.1
Forested Wetland	15.3	1.8	1.8	1.2	<0.1	4.9	0.5	3.9	1.1	0.1	1.1	0.1	0	0	0
Forested Upland	0		0	0	0	0		0	0	0	0		0	0	0
Shrubland	93.9	11.2	30.2	20.5	0.5	325.6	30.1	16.5	4.6	0.3	274.0	30.6	19.9	11.6	0.3
Tree Savanna	0.9	0.1	0	0	0	0.1	<0.1	<0.1	<0.1	<<0.1	0		1.1	0.7	0.1
Shrub Savanna	65.3	7.8	10.9	7.4	0.2	69.5	6.4	1.9	0.5	<0.1	181.9	20.3	12.9	7.5	0.2
Desertic Woodland	4.5	0.5	2.8	1.9	<0.1	0		0	0	0	0		0	0	0
Desertic Shrubland	2.9	0.3	2.3	1.6	<0.1	65.5	6.1	2.2	0.6	<0.1	65.6	7.3	2.5	1.5	<0.1
Desertic Herbland	7.9	0.9	0	0	0	0		0	0	0	0		0	0	0
Grassland	80.3	9.5	0	0	0	52.0	4.8	0.4	0.1	<0.1	2.2	0.2	4.1	2.4	0.1
Forbland	17.4	2.1	0	0	0	5.4	0.5	0.4	0.1	<0.1	6.3	0.7	0.1	<0.1	<0.1
Natural Features															
Barrenland	16.2	1.9	12.0	8.1	0.2	1.6	0.2	0.2	<0.1	<0.1	0.6	0.1	1.0	0.6	<0.1

Table 4. (Continued)

	Upper Salmon Falls					Lower Salmon Falls					Bliss				
	project area		project boundary		study area	project area		project boundary		study area	project area		project boundary		study area
Cover type	ha	%	ha	%	%	ha	%	ha	%	%	ha	%	ha	%	%
Cliff/Talus Slope	3.4	0.4	0.1	<0.1	<0.1	5.3	0.5	<0.1	<0.1	<<0.1	20.9	2.3	0.7	0.4	<0.1
Lentic	12.7	1.5	0	0	0	12.5	1.2	1.0	0.3	<0.1	0		0	0	0
Lotic	105.0	22.0	37.5	25.4	0.6	296.2	27.5	300.1	83.1	4.8	107.5	12.0	109.5	63.7	1.8
<u>Land Use</u>															
Disturbed	15.8	1.9	15.0	10.1	0.2	12.5	1.2	1.5	0.4	<0.1	8.9	1.0	3.2	1.9	0.1
Agriculture	96.9	11.5	0.8	0.6	<0.1	82.5	7.7	3.8	1.1	0.1	55.6	6.2	<0.1	<0.1	<<0.1
Grazing Land/Pasture	65.1	7.7	4.1	2.8	0.1	44.4	4.1	0.6	0.2	<0.1	130.8	14.6	<0.1	<0.1	<<0.1
Urban	6.9	0.8	0	0	0	0		0	0	0	0		0	0	0
Residential	33.7	4.0	3.2	2.1	0.1	3.8	0.4	0.5	0.1	<0.1	3.5	0.4	2.2	1.3	<0.1
Industrial	11.9	1.4	1.1	0.8	<0.1	7.4	0.7	1.6	0.5	<0.1	1.4	0.2	1.3	0.8	<0.1
Park/Recreation	2.7	0.3	0.8	0.5	<0.1	3.3	0.3	3.1	0.9	0.1	0.7	0.1	2.2	1.3	<0.1
Roads	18.5	2.2	4.2	2.8	0.1	8.1	0.8	1.6	0.5	<0.1	10.1	1.1	1.9	1.1	<0.1
Forested/Orchard	1.3	0.2	0.4	0.2	<0.1	7.2	0.7	0	0	0	1.9	0.2	2.0	1.2	<0.1
Total area typed	761.1	99.8	147.4	99.8		1078.9	100.0	360.8	100.0		896.6	100.1	172.1	100.3	

Table 5. Plant associations of the vegetation cover types of the Hagerman Study Area. Mnemonics used in the following tables to identify plant associations are included at right.

Cover Type	Plant Association	Mnemonic
Emergent Herbaceous Wetland	*Nasturtium officinale - Polygonum persicaria*	NAOF-POPE
	Scirpus acutus - Veronica anagallis-aquatica	SCAC-VEAN
	Scirpus acutus - Lemna sp.	SCAC-LEMNA
	Scirpus acutus - Lemna sp. *- Solanum dulcamara*	SCAC-LEMNA-SODU
Non-Emergent Herbaceous Wetland	*Salix exigua/Melilotus alba*	SAEX/MEAL
	Chenopodium album	CHAL
	Dipsacus fullonum - Bromus tectorum	DIFU-BRTE
Shore & Bottomland Wetland	*Scirpus acutus - Typha latifolia*	SCAC-TYLA
	Bromus tectorum - Euthamia occidentalis	BRTE-EUOC
Scrub-Shrub Wetland	*Rhus trilobata/Bromus tectorum*	RHTR-BRTE
	Salix exigua/Dipsacus fullonum - Solanum dulcamara	SAEX/DIFU-SODU
	Elaeagnus angustifolia - Salix exigua/Solanum dulcamara	ELAN-SAEX/SODU
Forested Wetland	*Salix* spp./*Rosa woodsii/Solanum dulcamara*	SALIX/ROWO/SODU
	Celtis reticulata/Rhus trilobata/Bromus tectorum	CERE/RHTR/BRTE
	Celtis reticulata/Bromus tectorum	CERE/BRTE
Shrubland	*Artemisia tridentata/Bromus tectorum*	ARTR/BRTE
	Salix exigua - Rhus trilobata/Bromus tectorum	SAEX-RHTR/BRTE
	Elaeagnus angustifolia/Chenopodium album	ELAN/CHAL
	Salix exigua/Melilotus alba	SAEX/MEAL
Shrub Savanna	*Toxicodendron radicans - Rosa woodsii/Glycyrrhiza lepidota*	TORA-ROWO/GLLE
	Salix exigua/Melilotus alba - Kochia scoparia	SAEX/MEAL-KOSC
	Dipsacus fullonum/Elaeagnus angustifolia - Purshia tridentata	DIFU/ELAN-PUTR
	Artemisia tridentata/Bromus tectorum	ARTR/BRTE
	Chrysothamnus nauseosus/Bromus tectorum	CHNA/BRTE

Table 5. (Continued)

Cover Type	Plant Association	Mnemonic
Forbland	*Melilotus alba - Dipsacus fullonum*	MEAL-DIFU
Desertic Herbland	*Bromus tectorum-Sisymbrium altissimum*	BRTE-SIAL

Table 6. Constancy[1] and abundance[2] (constancy/frequency/cover) of selected species in *Emergent Herbaceous Wetland* associations. tr = trace, n = number of transects representing an association.

	Association			
Lifeform & Species	NAOF-POPE n = 10	SCAC-VEAN n = 7	SCAC-LEMNA n = 4	SCAC-LEMNA -SODU n = 6
Trees:				
Fraxinus pennsylvanica	10/tr/0.1			
Salix spp.		14/tr/0.3		67/7/3.3
Shrubs:				
Salix exigua	40/13/2.5	29/9/3.9	75/9/2.7	83/4/1.4
Herbs:				
Nasturtium officinale	60/56/13.4	86/10/0.9		
Polygonum persicaria	70/21/4.3			
Bidens frondosa	60/13/7.7			
Veronica anagallis-aquatica	70/19/2.9	86/27/2.3		
Polypogon monspeliensis	90/43/2.2	57/18/1.0		
Scirpus acutus		86/53/14.0	100/98/16.4	100/88/32.7
Typha latifolia		71/14/2.0		83/2/4.6
Lycopus asper		84/14/0.9		
Lemna sp.			100/76/27.2	67/46/18.0
Solanum dulcamara			75/18/3.5	83/42/14.8
Lythrum salicaria				67/9.7/2.1
Lifeform Cover and Surface Features				
Mean total vegetative cover (%)	54.8	47.2	60.3	79.3
Mean tree cover (%)	<0.1	0.4	0	2.8
Mean shrub cover (%)	1.3	5.4	8.9	1.6
Mean herbaceous cover (%)	53.5	41.3	51.4	75.0
Litter (%)	0	0.5	23.9	22.6
Moss (%)	0	0	0	0
Lichen (%)	0	0	0	0
Dead woody species (%)	0	5.9	0.4	0

[1]Constancy refers to the representation of a species among transects in an association.

[2]Abundance is measured as frequency of occurrences among sample points of all transects in an association and average cover among transects. See text for further explanation.

Table 7. Constancy[1] and abundance[2] (constancy/frequency/cover) of selected species in the *Non-Emergent Herbaceous* associations. tr = trace, n = number of transects representing an association.

	Associaton		
Lifeform & Species	SAEX/MEAL n = 24	CHAL n = 3	DIFU-BRTE n = 7
Trees:			
Morus alba	.04/tr/0.7		
Salix spp.	25/tr/0.3	33/tr/0.9	
Shrubs:			
Salix exigua	83/25/9.0	67/10/3.1	29/11/3.4
Elaeagnus angustifolia	42/3/1.5		29/9/3.9
Chrysothamnus nauseosus			43/4/2.0
Purshia tridenta			43/4/1.7
Artemisia tridentata			43/4/1.0
Herbs:			
Melilotus alba	67/31/9.2		
Dipsacus fullonum	79/2/4.9		86/39/10.4
Euthamia occidentalis	75/20/2.3		86/14/1.1
Polypogon monspeliensis	75/31/1.7		
Chenopodium album		100/77/25.5	
Cirsium arvense		67/17/3.6	
Scirpus acutus		67/38/2.5	
Rumex crispus			86/12/1.1
Bromus tectorum			86/45/3.9
Lycopus asper			71/9/1.4
Lifeform Cover and Surface Features:			
Mean total vegetative cover (%)	70.1	60.0	60.4
Mean tree cover (%)	0.5	0.9	1.4
Mean shrub cover (%)	10.5	4.4	14.2
Mean herbaceous cover (%)	59.1	54.3	44.7
Rock (%)	17.5	0	34.1
Litter (%)	16.2	19.9	17.5
Moss (%)	<<0.1	0	2.3
Lichen (%)	0	0	0

[1]Constancy refers to the representation of a species among transects in an association.

[2]Abundance is measured as frequency of occurrence among sample points of all transects in an association and average cover among transects. See text for further explanation.

Table 8. Constancy[1] and abundance[2] (constancy/frequency/cover) of selected species in the *Shore & Bottomland Wetland* associations. tr = trace, n = number of transects representing an association.

	Association	
Lifeform & Species	SCAC-TYLA n = 5	BRTE-EUOC n = 4
Trees:		
None		
Shrubs:		
Elaeagnus angustifolia	20/tr/0.8	tr
Salix exigua		50/8/3.0
Herbs:		
Scirpus acutus	100/42/6.7	
Typha latifolia	60/42/2.7	
Bromus tectorum		
Euthamia occidentalis		75/11/2.7
Helenium autumnale		75/8/0.7
Lifeform Cover and Surface Features		
Mean total vegetation cover (%)	17.2	24.9
Mean tree cover (%)	0	0
Mean shrub cover (%)	1.0	3.4
Mean herbaceous cover (%)	16.3	21.5
Rock (%)	9.1	48.1
Litter (%)	18.8	29.8
Moss	0	0
Lichen	0	0

[1]Constancy refers to the representation of a species among transects in an association.

[2]Abundance is measured as frequency of occurrence among sample points of all transects in an association and average cover among transects. See text for further explanation.

Table 9. Constancy[1] and abundance[2] (constancy/frequency/cover) of selected species in the *Scrub-Shrub Wetland* associations. tr = trace, n = number of transects representing an association.

	Association		
Lifeform & Species	RHTR-ROWO/BRTE n = 10	SAEX/DIFU-SODU n = 13	ELAN-SAEX/SODU n = 15
Trees:			
Celtis reticulata	50/7/6.5		
Fraxinus pennsylvanica		31/2/0.8	
Salix spp.		31/1/1.0	60/12/6.9
Shrubs:			
Rhus trilobata	90/50/34.4	38/10/4.2	27/5/3.2
Rosa woodsii	70/23/13.8		40/13/5.2
Salix exigua	50/12/5.9	100/62/34.6	73/35/16.8
Ribes aureum	60/12/5.2	54/7/2.1	60/7/1.8
Toxicodendron radicans	50/11/4.9	54/4/1.1	
Elaeagnus angustifolia			73/28/25.7
Herbs:			
Dipsacus fullonum	50/7/1.5	100/24/6.8	80/18/4.9
Bromus tectorum	80/39/1.6	85/17/0.4	
Melilotus alba	50/5/1.1		
Solanum dulcamara	50/6/4.1	92/20/5.8	87/33/7.7
Euthamia occidentalis		69/17/2.4	67/16/2.6
Apocynum cannabinum		85/19/3.2	
Cirsium arvense		85/6/1.4	60/14/2.9
Rumex crispus		85/4/0.5	
Chenopodium album			73/14/4.6
Lycopus asper			73/17/2.3
Lifeform Cover and Surface Features:			
Mean total vegetative cover (%)	92.8	91.4	109.4
Mean tree cover (%)	7.3	3.1	6.3
Mean shrub cover (%)	67.7	45.9	59.4
Mean herbaceous cover (%)	17.8	42.4	43.7
Rock (%)	11.2	16.2	0.4
Litter (%)	31.4	16.2	20.2
Moss (%)	<0.1	0	0
Lichen (%)	<<0.1	0	0

[1]Constancy refers to the representation of a species among transects in an association.

[2]Abundance is measured as frequency of occurrence among sample points of all transects in an association and average cover among transects. See text for further explanation.

Table 10. Constancy[1] and abundance[2] (constancy/frequency/cover) of selected species in the *Forested Wetland* associations. tr = trace, n = number of transects representing an association.

	Association		
Lifeform & Species	SALIX/ROWO/ SODU n = 4	CERE/RHTR/BRTE n = 3	CERE/BRTE n = 3
Trees:			
Salix spp.	100/65/48.1		
Celtis reticulata		100/57/47	100/94/82.8
Shrubs:			
Rosa woodsii	100/28/14.9		
Toxicodendron radicans	50/10/7.9	100/21/9.3	
Salix exigua	100/11/8.0		
Elaeagnus angustifolia	75/7/6.3		
Rhus trilobata	100/10/4.0	100/42/32.4	
Ribes aureum	75/14/3.4	100/18/7.8	67/8/8.1
Herbs:			
Solanum dulcamara	100/49/17.3		
Dipsacus fullonum	100/17/6.4		
Euthamia occidentalis	100/15/2.6		
Lycopus asper	75/9/1.5		
Bromus tectorum		100/34/2.1	100/6/1.7
Melilotus alba			67/19/0.9
Lifeform Cover and Surface Features:			
Mean total vegetative cover (%)	142.4	110.3	94.4
Mean tree cover (%)	50.4	48.3	82.9
Mean shrub cover (%)	40.1	51.9	8.1
Mean herbaceous cover (%)	51.9	10.1	3.4
Rock (%)	0	5.9	16.7
Litter (%)	65.5	22.8	11.9
Moss (%)	0.3	<0.1	0
Lichen (%)	0	0	0

[1]Constancy refers to the representation of a species among transects in an association.

[2]Abundance is measured as frequency of occurrence among sample points of all transects in an association and average cover among transects. See text for further information.

Table 11. Constancy[1] and abundance[2] (constancy/frequency/cover) of selected species in the *Shrubland* associations. tr = trace, n = number of transects representing an association.

Lifeform & Species	Association			
	ARTR/BRTE n = 5	SAEX-RHTR/BRTE n = 7	ELAN/CHAL n = 7	SAEX/MEAL n = 4
Trees:				
Salix spp.		43/9/3.5		
Morus alba		29/2/0.8		
Ulmus pumila				25/1/1.3
Shrubs:				
Artemisia tridentata	100/50/25.4			
Salix exigua		86/47/24.6	29/24/6.1	100/55/26.5
Rhus trilobata		71/35/24.3		
Rosa woodsii		57/26/11.0	43/9/2.0	
Elaeagnus angustifolia		29/4/7.5	100/66/56.3	50/19/16.3
Toxicodendron radicans		43/16/5.3		
Ribes aureum		71/9/1.8		75/5/0.7
Herbs:				
Bromus tectorum	100/97/8.6	86/36/1.4	43/23/0.9	
Poa secunda	80/30/2.0			
Sisymbrium altissimum	80/12/0.7			
Glycerrhiza lepidota		29/4/3.3		75/15/5.8
Dipsacus fullonum		43/5/1.2		50/15/4.7
Chenopodium album			29/20/3.4	
Distichlis spicata			57/11/1.7	
Phalaris arundinacea			29/11/0.9	
Melilotus alba				100/57/26.7
Euthamia occidentalis				100/31/3.8
Apocynum cannabinum				75/19/2.5
Lifeform Cover and Surface Features:				
Mean total vegetative cover (%)	46.6	100.1	91.0	110.0
Mean tree cover (%)	0	6.2	0	0.7
Mean shrub cover (%)	31.0	74.8	66.7	49.6
Mean herbaceous cover (%)	15.6	19.2	24.3	59.7

Table 11. (Continued)

Lifeform & Species	Association ARTR/BRTE n = 5	 SAEX- RHTR/BRTE n = 7	 ELAN/CHAL n = 7	 SAEX/MEAL n = 4
Lifeform Cover and Surface Features:	(continued)			
Rock (%)	no estimate	1.3	<0.1	15.9
Litter (%)	no estimate	42.8	38.4	4.7
Moss (%)	no estimate	0.1	0	0
Lichen (%)	no estimate	0	0	0
Dead shrub (%)	3.1	2.3	0.4	2.0

[1]Constancy refers to the representation of a species among transect in an association.

[2]Abundance is measured as frequency of occurrence among sample points of all transects in an association and average cover among transects. See text for further explanation.

Table 12. Constancy[1] and abundance[2] (constancy/frequency/cover) of selected species in the *Shrub Savanna* associations. tr = trace, n = number of transects representing an association.

	Association				
Lifeform & Species	Mixed Shrub/GLLE n = 5	SAEX/MEAL n = 4	DIFU/Mixed Shrub n = 3	ARTR/BRTE n = 5	CHNA/BRTE n = 6
Trees:					
Celtis reticulata	40/2/1.8	25/2/0.9	30/tr/0.1	20/2/2.0	
Fraxinus pennsylvanica	20/2/0.3	25/1/0.2	30/tr/0.7		
Salix spp.			30/tr/0.2		
Shrubs:					
Toxicodendron radicans	60/14/3.5				
Rosa woodsii	60/7/2.4				
Artemisia ludoviciana	40/14/1.7				
Salix exigua	60/7/1.5	75/31/13.5			
Rhus trilobata	60/6/1.5				
Ribes aureum	40/2/0.5	25/4/1.2			
Artemisia tridentata		50/6/1.0		80/3/10.1	33/3/1.6
Elaeagnus angustifolia			60/9/8.0		
Chrysothamnus nauseosus			100/5/2.2	40/3/1.4	100/15/7.0
Chrysothamnus viscidiflorus				20/9/4.1	67/6/1.4
Grayia spinosa					50/5/2.9
Herbs:					
Cirsium arvense	40/7/8.6				
Glycyrrhiza lepidota	60/33/5.6				
Elymus cinereus	60/7/3.5				
Bromus tectorum	100/73/1.9			100/27/13.2	100/91/11.6
Grindelia squarrosa	60/16/1.5				
Melilotus alba	60/25/1.2	100/32/17.6	100/16/1.6		
Kochia scoparia		25/27/14.0			
Xanthium strumarium		75/11/2.8			
Dipsacus fullonum		75/9/1.8	100/51/12.9		
Solanum dulcamara			100/15/4.3		
Euthamia occidentalis			100/14/4.1		
Polypogon monspeliensis			60/20/3.8		

Table 12. (Continued)

Lifeform & Species	Mixed Shrub/GLLE n = 5	SAEX/MEAL n = 4	DIFU/Mixed Shrub n = 3	ARTR/BRTE n = 5	CHNA/BRTE n = 6
	Association				
Herbs continued:					
Erodium cicutarium				40/27/4.9	
Sisymbrium altissimum				80/9/3.4	83/21/4.4
Poa secunda				80/21/1.6	
Salsola kali				80/4/0.8	17/6/1.1
Stipa comata					33/6/1.6
Aster chilensis					67/6/0.5
Lifeform Cover and Surface Features:					
Mean total vegetative cover (%)		74.6	88.6	53.7	38.4
Mean tree cover (%)	2.1	1.1	1.0	2.0	0
Mean shrub cover (%)	10.4	16.9	19.7	19.4	13.7
Mean herbaceous cover (%)	28.6	56.7	67.9	32.3	24.7
Rock (%)	14.4	0	0	not estimated	
Litter (%)				not estimated	
Moss (%)	0	0	0	not estimated	
Lichen (%)	0	0	0	not estimated	
Dead Shrub	0.3	1.3	0.9	6.2	0.5

[1]Constancy refers to the representation of a species among transects in an association.

[2] Abundance is measured as frequency of occurrence among sample points of all transects in an association and average cover among transects. See text for further explanation.

Table 13. Constancy[1] and abundance[2] (constancy/frequency/cover) of selected species in the *Forbland* association. tr = trace, n = number of transects representing an association.

Lifeform & Species	Association MEAL-DIFU n = 7
Trees:	
Salix spp.	14/tr/0.1
Shrubs:	
Salix exigua	57/7/1.2
Herbs:	
Melilotus alba	57/31/12.3
Dipsacus fullonum	86/32/9.2
Euthamia occidentalis	71/28/5.7
Lifeform Cover and Surface Features:	
Mean total vegetative cover (%)	73.4
Mean tree cover (%)	0.2
Mean shrub cover (%)	2.2
Mean herbaceous cover (%)	71.0
Rock (%)	7.5
Lichen (%)	1.3
Moss (%)	0
Litter (%)	0

[1]Constancy refers to the representation of a species among transects in an association.

[2]Abundance is measured as frequency of occurrence among sample points of all transects in an association and average cover among transects. See text for further explanation.

Table 14. Constancy[1] and abundance[2] (constancy/frequency/cover) of selected species in the *Desertic Herbland* association. tr = trace, n = number of transects representing an association.

Lifeform & Species	Association BRTE-SIAL n = 4
Trees:	
None	
Shrubs:	
Chrysothamnus nauseosus	50/10/2.0
Herbs:	
Bromus tectorum	100/82/4.5
Sisymbrium altissimum	75/22/2.5
Lifeform Cover and Surface Features:	
Mean total vegetative cover (%)	19.6
Mean tree cover (%)	0
Mean shrub cover (%)	2.0
Mean herbaceous cover (%)	17.6
Rock (%)	0
Litter (%)	32.9
Moss (%)	0.3
Lichen (%)	0

[1]Constancy refers to the representation of a species among transects in an association.

[2]Abundance is measured as frequency of occurrence among sample points of all transects in an association and average cover among transects. See text for further explanation.

Table 15. Fire occurrence records for the Hagerman Study Area and vicinity. Information provided by the Boise District Fire Office, B.L.M. lght = Lightening.

Year	Number of fires	Cause		ownership		Acres burned	
		man	lght	B.L.M.	private	total	reburned
1979	21	19	2	16060	292	16352	0
1980	9	9	0	5480	1040	16520	0
1981	15	13	2	20036	1334	21370	0
1982	17	13	4	8691	833	9524	
1983	17	8	9	52527	8278	60805	5765
1984	20	6	14	54790	16127	70917	33458
1985	21	15	6	17179	814	17993	1370
1986	27	27	0	6992	3101	10093	5666
1987	27	14	13	28442	36316	64758	61686
1988	3	2	1	31	60	91	30
1989	14	5	9	1004	56	1060	8
1990	9	8	1	231	388	619	0
1991	1	1	0	5	0	5	0
Total	201	140	61	22 1,468	68,63 9	290,107	108,678
% of Total		70	30	76	24		38

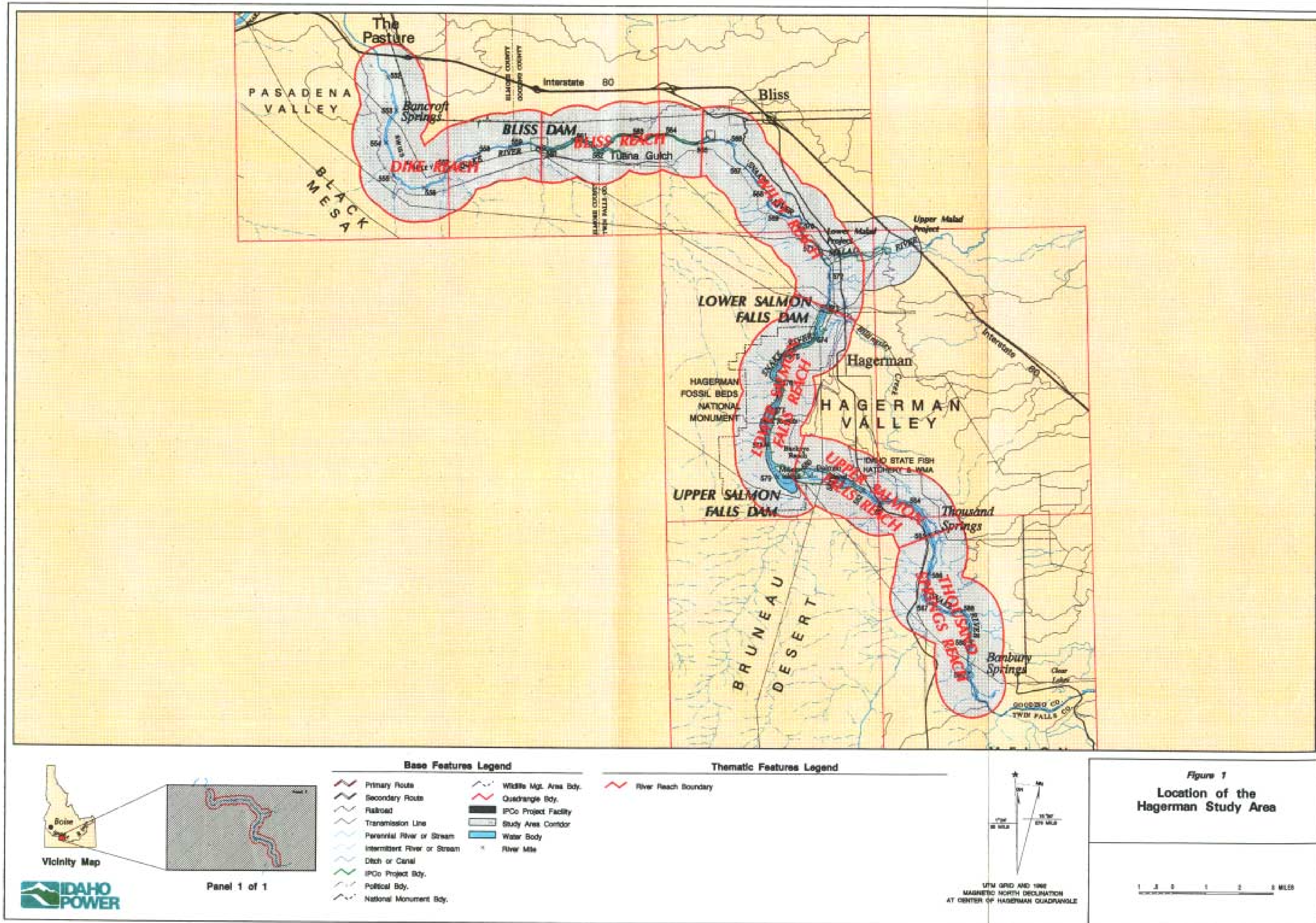
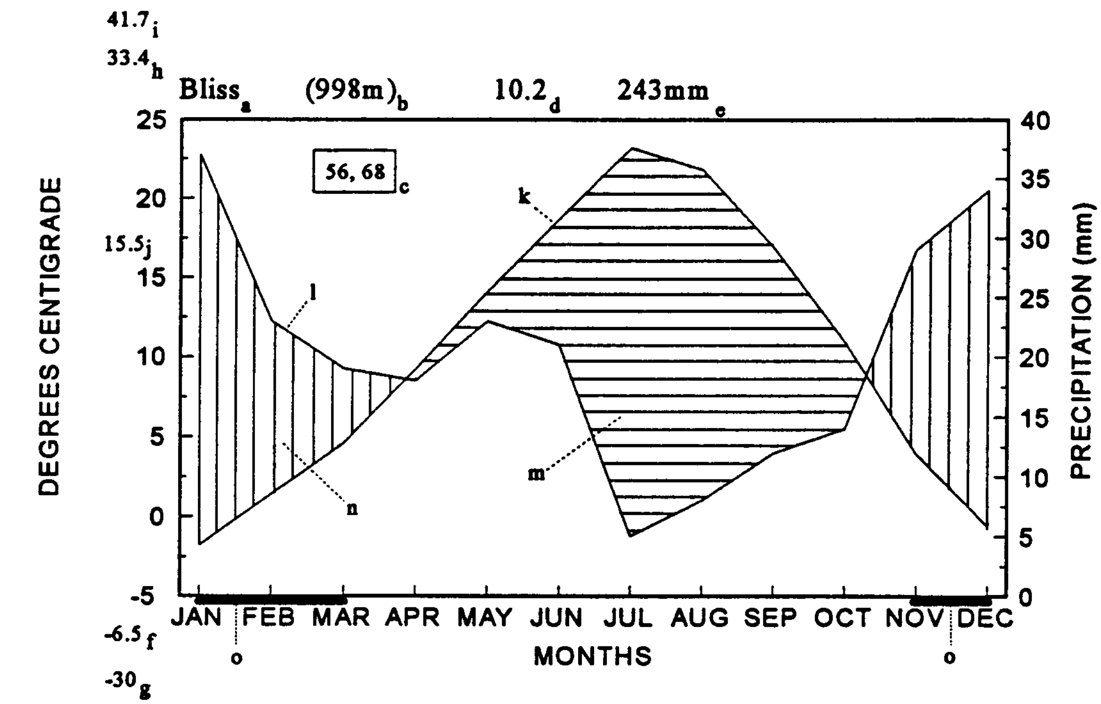


Figure 1

Location of the Hagerman Study Area

Figure 2. Köppen climate diagram for the Bliss weather station, Hageman Study Area, southwestern Idaho



a: Station
b: Elevation
c: Number of years of observation (temperature, precipitation)
d: Mean annual temperature in °C
e: Mean annual precipitation in millimeters
f: Mean daily minimum of the coldest month
g: Lowest recorded temperature
h: Mean daily maximum of the hottest month
i: Highest recorded temperature
j: Mean daily temperature range
k: Monthly means of temperature in °C
l: Monthly means of precipitation in millimeters
m: Arid period (horizontal hatched)
n: Humid period (vertical hatched)
o: Months with an absolute minimum below 0 °C

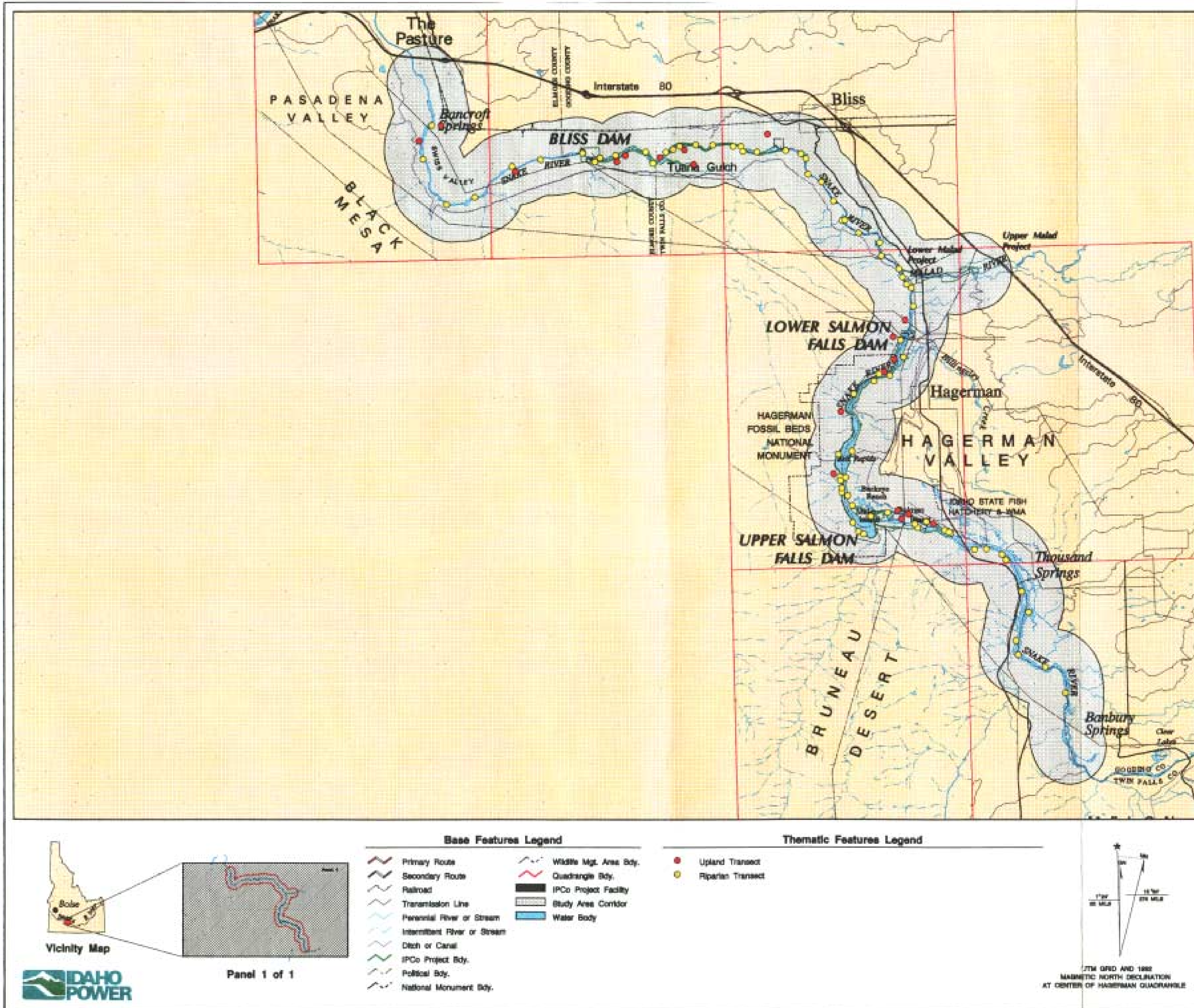
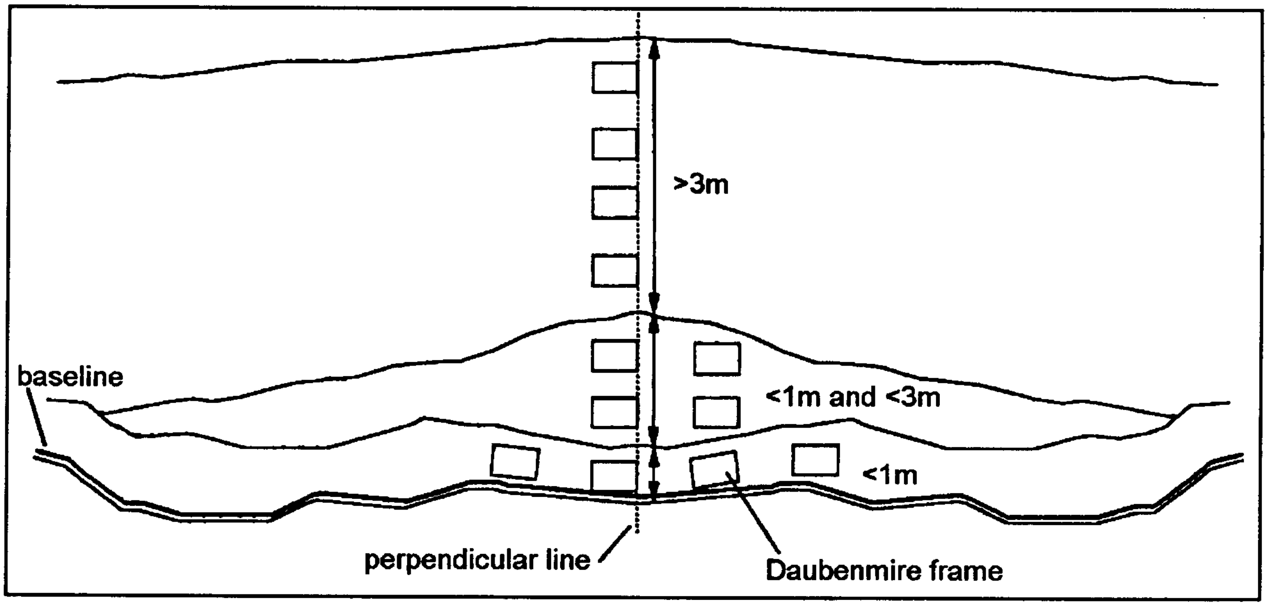


Figure 3

Riparian and Upland Transects in the Hagerman Study Area

Figure 4. Placement of Daubenmire frames within vegetation communities occurring in riparian vegetation. The distribution of frames is determined by the width of the community along the perpendicular line.



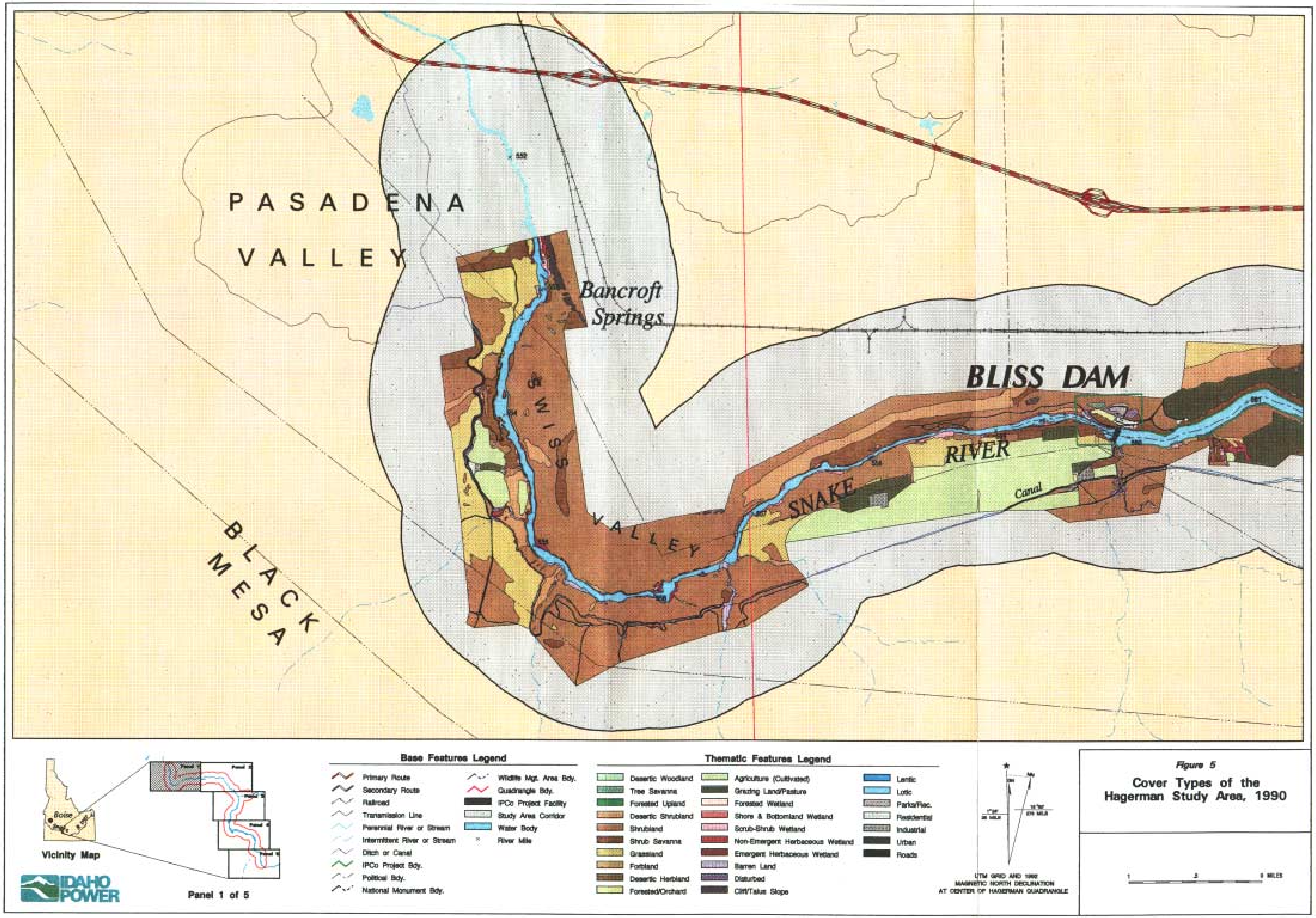


Figure 5

Cover Types of the Hagerman Study Area, 1990

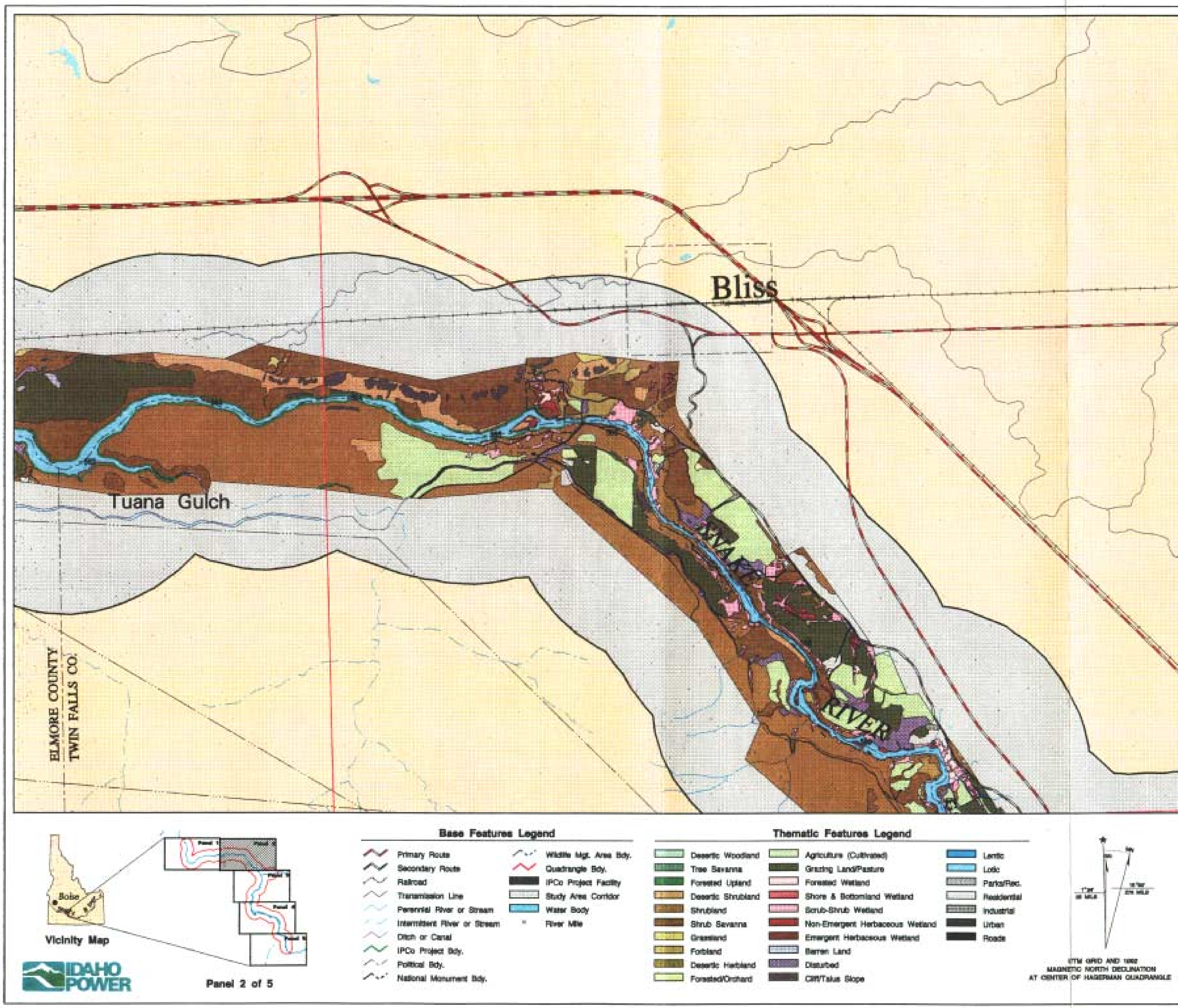


Figure 5

Cover Types of the Hagerman Study Area, 1990

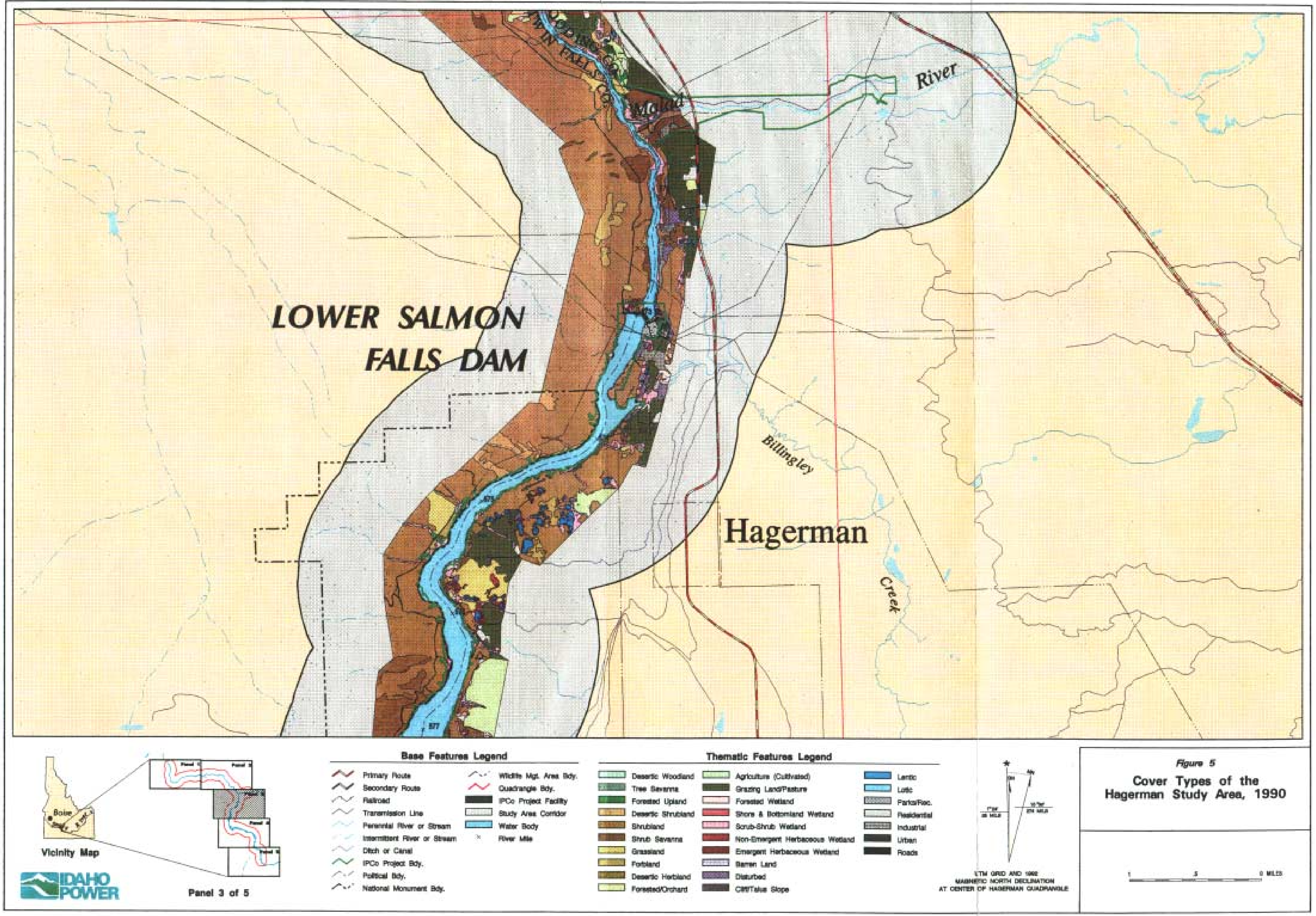


Figure 5

Cover Types of the Hagerman Study Area, 1990

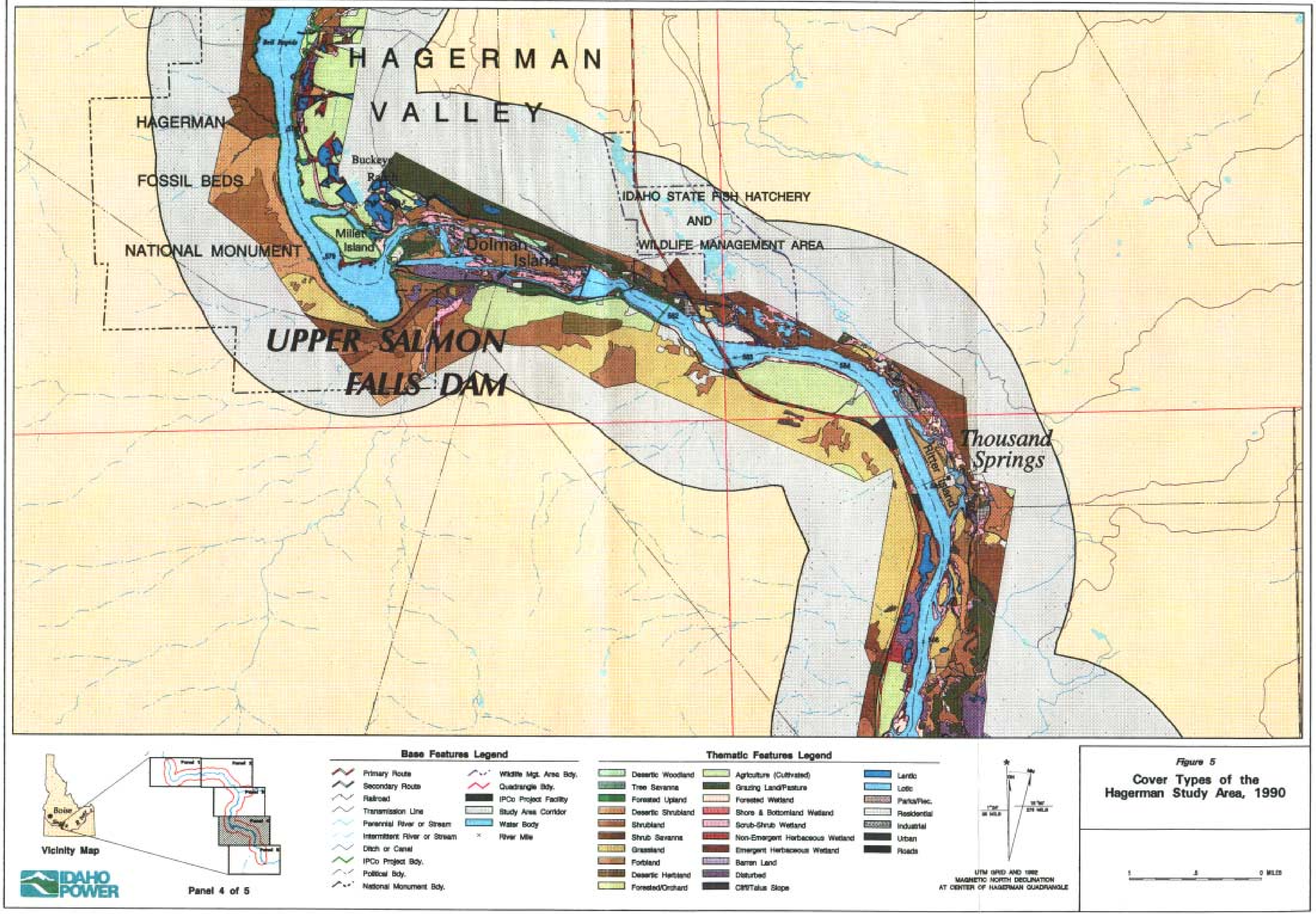


Figure 5

Cover Types of the Hagerman Study Area, 1990

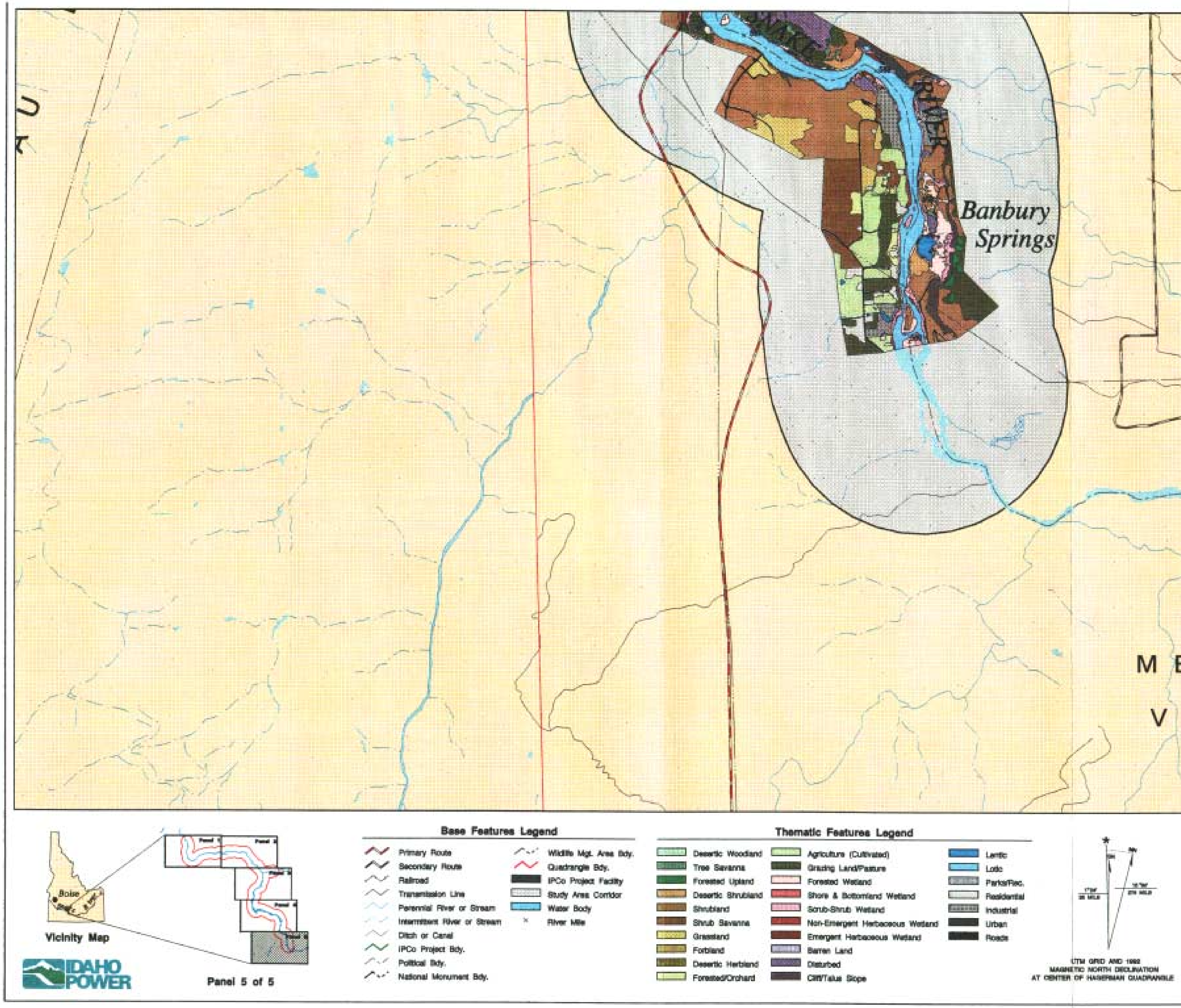
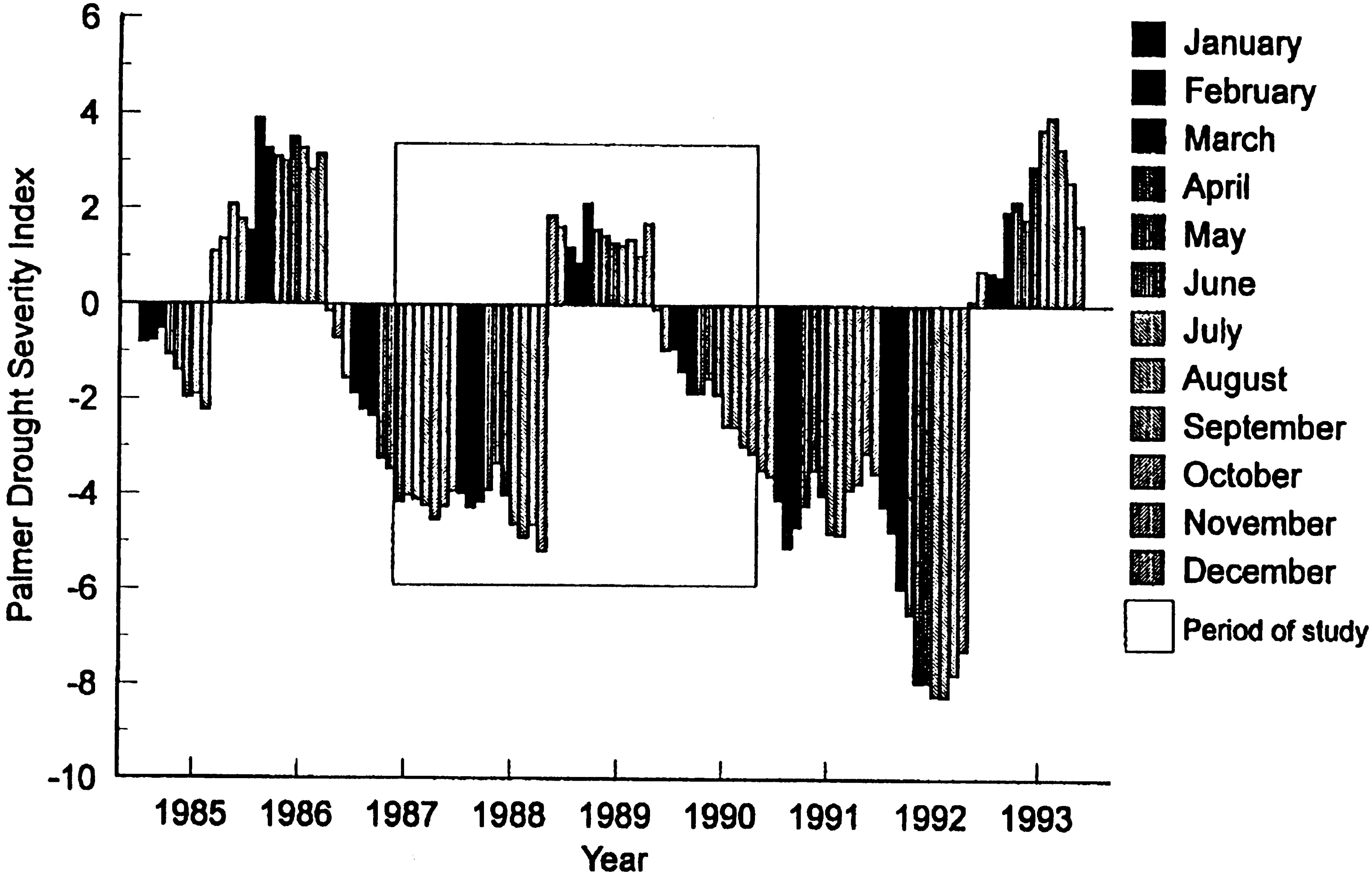


Figure 5

Cover Types of the Hagerman Study Area, 1990

Figure 6. Drought conditions occurring in the vicinity of the Hagerman Study Area from 1985-1993. Data provided by the Idaho State Climatologist, Univ. Of Id., Moscow.



Appendix 1. Criteria used to delineate vegetation cover types. Definitions of these and the other cover types used for the development the cover type map for the Hagerman Study Area.

No.	Cover type	Total woody cover (%)	Total tree cover (%)	Total shrub cover (%)	Total herb cover (%)	Total veg. cover (%)	Comment
1	Emergent Herbaceous Wetland	<30			>30	>30	Emergent community dominated by perennial vegetation
2	Non-Emergent Herbaceous Wetland	<30			>30	>30	Riparian community
3	Shore & Bottomland Wetland					<30	Emergent and riparian communities (if vegetation present)
4	Scrub-Shrub Wetland	>30	<30	>30		>30	Riparian community, woody vegetation <6 m tall
5	Forested Wetland	>30	>30			>30	Riparian community, woody vegetation ≥6 m tall
8	Forested Upland		≥25			≥25	Upland community, trees >5 m tall
9	Shrubland			≥25		>25	Upland community, may include trees <5 m tall
10	Tree Savanna		5<X <25			≥25	Upland community, trees >5 m tall
11	Shrub Savanna			5<X<25		≥25	Upland community, may include trees <5 m tall
12	Desertic Woodland		domi nant			≤25	Upland community, trees >5 m tall
13	Desertic Shrubland			dominant		≤25	Upland community, may have trees <5 m tall
14	Desertic Herbland				dominant	≤25	Upland community
15	Grassland				Grass> Forb	≥25	Upland community
16	Forbland				Forb> Grass	≥25	Upland community
17	Barrenland					≤5	Upland community, undisturbed
18	Cliff/Talus					≤5	Upland community
19	Disturbed					<15	Upland community, >50% disturbed by human activities

Appendix 1 (Continued)

Definitions

1. Emergent Herbaceous Wetland - is dominated by more than 30% cover of emergent, erect, rooted, herbaceous hydrophytes. This vegetation is present for most of the growing season in most years and is usually dominated by perennial plants. It has less than 30% cover of woody vegetation and a total vegetation cover of more than 30%.

2. Non-Emergent Herbaceous Wetland - is dominated by more than 30% cover of non-emergent, erect, rooted, herbaceous vegetation. This cover type is only found in the riparian zone, and has less than 30% cover of woody vegetation and a total vegetation cover of more than 30%.

3. Shore & Bottomland Wetland - may consist of bare sand, gravel, or rocky areas along the riparian zone. If vegetation is present, it is dominated by emergent vegetation with a total vegetation cover less than 30%.

4. Scrub-Shrub Wetland - is dominated by woody wetland vegetation less than 6 m (20 feet) tall. It has a total vegetation cover greater than 30%.

5. Forested Wetland - is dominated by woody wetland vegetation that is 6 m (20 feet) tall or taller. It has a total vegetation cover greater than 30%.

6. Lentic - is non-moving open water habitat such as ponds and lakes.

7. Lotic - is moving open water habitat such as rivers and streams.

8. Forested Upland - is dominated by trees (taller than 5 m) and has a tree canopy cover of at least 25%.

9. Shrubland - an upland vegetation community, dominated by shrubs (including small trees shorter than 5 m) and has a shrub canopy cover of at least 25%. Total vegetation cover is greater than 25%.

10 Tree Savanna - an upland community, with a canopy cover of trees (taller than 5 m) between 5% and 25%. Total vegetation cover is at least 25%. The area between trees is typically dominated by grasses or other herbaceous vegetation.

11 Shrub Savanna - an upland community, with a canopy cover of shrubs (including small trees shorter than 5 m) between 5% and 25%. This cover type has a total vegetation cover of at least 25%. The area between shrubs is typically dominated by grasses or other herbaceous vegetation.

Appendix 1 (Continued)

12. Desertic Woodland - an upland community with l-25% total vegetation cover and trees (taller than 5 m) forming the dominant vegetation stratum. It includes sparsely vegetated types in non-desert areas.

13. Desertic Shrubland - an upland community with l-25% total vegetation cover and shrubs (and small trees shorter than 5 m) forming the dominant vegetation stratum. This cover type includes sparsely vegetated habitats in non-desert areas.

14. Desertic Herbland - an upland community with l-25% total vegetation cover, and non-woody plants (including lichens and mosses) forming the dominant vegetation stratum. It includes sparsely vegetated types in non-desert areas.

15. Grassland - an upland community with a total vegetation cover of at least 25%, and dominated by non-woody plants (including lichens and mosses), of which grasses (native or introduced) are dominant. This cover type may include prairies, rangeland, and upland subalpine meadows.

16. Forbland - an upland community with a total vegetation cover of at least 25%, and dominated by non-woody plants (including lichens and mosses), of which forbs (native or introduced) are dominant. This cover type includes many weedy fields, old fields, and other types in early successional stages.

17. Barrenland (e.g.. Sand Dunes] - is an undisturbed (by direct human influence) upland area that has a total vegetation cover of 5% or less.

18. Cliff/Talus Slope - consists of nearly vertical rock or bare soil faces, or slopes of unconsolidated rock material with a total vegetation cover of 5% or less.

19. Disturbed - is land with more than 50% of the area disturbed by human activities and has a total vegetation cover of less than 15%. This cover type may include off-road vehicle areas, rural trash dumps, and soil borrow pits.

20. Agriculture (Cultivated) - land that is principally used for the production of agricultural crops or products.

21. Grazing Land/Pasture - land that is principally used for pasture or grazing of domestic livestock.

22. Urban - land that is principally located in a city and pertaining to city life (i.e., small business buildings and facilities).

Appendix 1 (Continued)

23. Residential - land that is principally associated with human housing. This cover type may include homes, garages, yards, gardens, sidewalks, driveways, and small livestock pens and pastures (l-2 acres).

24. Industrial - land that is principally used for larger businesses and corporations such as office complexes, manufacturing plants, and warehouses.

25. Parks/Recreation - cultivated landscape that is principally used for human recreation such as city and county parks, roadside rest areas and picnic areas.

26. Roads - consists of roadways for vehicle travel including major freeways and highways, local paved roads, improved gravel and dirt roads. This cover type may be mapped as a linear feature rather than a polygon.

27. Forested/Orchard - is artificially planted and cultivated trees for the production of fruit or nut crops, or timber.

Appendix 2 - Two-way indicator species analysis with plant species cover data from the Emergent Herbaceous Wetland cover type, Hagerman Study Area, 1987-1990. Values in the table denote categories of abundance. Cut levels used were the default values 1, 2, 5, 10, and >20% cover. Shaded area separates classes of samples at level 3. Dashed lines separate classes of species at level 2. Species codes are defined in Appendix 11.

	9	11	13	26	15	27	1	3	4	5	2	16	17	23	6	7	8	10	12	20	19	25	28	29	18	21	22	24	14	30	
17 LASE	-	-	1	1	1	-	2	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000000
23 EQAR	-	-	-	1	1	-	1	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000000
31 POAM	-	-	-	2	-	-	1	2	-	2	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	000000
36 HEAU	-	-	1	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000000
37 MEAL	-	-	1	3	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	000000
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34 EUOC	-	-	-	-	2	-	1	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000001
44 EQLA	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000001
3 POMO	2	1	2	2	-	3	1	1	1	1	1	1	1	1	-	-	1	-	2	1	-	-	-	-	-	-	-	-	-	-	00001
25 PLMA	-	1	1	4	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00001
47 TRIFO	2	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00001
33 XAST	-	-	-	-	-	-	1	2	-	-	1	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	000100
50 CANE	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	000100
56 JUNCU	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	000100
57 PODO	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
61 RASC	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
30 MEAR	-	-	2	-	-	-	-	-	1	-	1	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	000101
27 CAHY	-	-	-	-	-	-	-	2	-	2	3	-	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	000110
45 LYAM	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	000110
35 GAAP	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000111
38 ROPA	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	000111
66 UFORB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	000111
13 CHAL	1	-	-	-	-	-	2	1	1	1	1	-	-	-	2	1	-	1	-	-	-	1	-	-	-	-	-	-	1	-	00100
15 PHAR	-	-	1	-	-	-	2	1	1	2	-	-	1	1	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	1	00100
18 DSHRB	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	4	3	2	5	-	1	1	-	-	-	-	-	-	-	-	00100
24 LEOR	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	00100
2 VEAN	3	5	2	-	-	1	2	1	1	-	4	1	1	-	1	1	1	-	1	1	1	-	-	-	-	1	-	-	-	-	00101
11 POPE	2	3	5	-	-	-	1	2	1	2	2	-	1	2	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	00101
21 BEER	1	-	-	-	1	-	-	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	00101
19 ELEOC	-	2	-	-	-	-	-	1	1	1	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	00110
59 POLYG	-	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001110
60 RANUN	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001110
62 RORIP	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001110
63 RUMA	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001110
52 ECCR	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001111
6 LYAS	-	-	-	3	-	-	1	1	-	1	1	1	-	-	1	1	1	2	1	1	-	-	-	-	1	-	1	-	-	-	0100
14 DIFU	-	-	-	3	1	-	1	2	1	1	2	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	3	-	0100
9 RUCR	1	-	2	-	1	1	2	2	1	-	-	-	-	-	-	2	-	1	-	-	1	1	-	-	-	-	-	-	1	3	0101
32 URDI	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-	0101
42 CIAR	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	0101
43 ELPA	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0101
22 BICE	1	2	-	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	011
39 UPLANT	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	011
40 APCA	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	011
46 SACU	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-	011
8 TYLA	-	-	-	-	-	-	-	1	-	-	1	3	-	2	1	-	1	2	4	1	-	1	-	-	2	2	3	2	-	-	10
49 ASFA	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1100
54 FRPE	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1100
16 EPGL	5	1	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	4	-	-	-	-	-	1	1	1	2	-	11010
1 SCAC	1	-	-	-	-	-	1	1	2	1	1	1	4	1	5	4	2	-	4	2	2	5	5	4	4	5	5	5	5	4	11011

Appendix 2 (continued)

	9	11	13	26	15	27	1	3	4	5	2	16	17	23	6	7	8	10	12	20	19	25	28	29	18	21	22	24	14	30	
7 SAEX	-	-	-	-	-	2	2	2	1	-	-	-	-	-	-	-	5	3	-	2	2	2	4	-	2	1	-	1	1	-	11011
26 SAAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	3	1	1	2	-	-	11011
53 ELAN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	4	-	-	-	-	-	-	11011
4 SODU	-	-	-	-	3	-	1	-	1	1	-	1	-	-	1	1	-	1	-	-	3	2	1	-	5	4	5	3	3	-	111
5 LEMNA	-	-	-	-	-	-	3	-	-	-	-	-	1	-	-	1	1	1	1	5	5	4	5	4	5	5	3	-	-	-	111
29 LYSA	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	2	-	3	-	-	111
65 SCTA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	111
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	
	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	
			0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1		

Appendix 3 - Two-way indicator species analysis with plant species cover data from the Non-Emergent Herbaceous Wetland cover type, Hagerman Study Area, 1987-1990. Values in the table denote categories of abundance. Cut levels used were the default values 1, 2, 5, 10, and >20% cover. Shaded area separates classes of samples at level 3. Dashed lines separate classes of species at level 1. Species codes are defined in Appendix 11.

	26	28	30	10	14	13	19	31	1	2	3	4	8	9	11	15	17	23	22	5	6	16	32	7	20	21	29	12	25	33	24	27	18	34	
17 EQAR	-	-	-	1	1	-	-	-	2	2	1	2	1	1	2	1	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	000000
48 BICE	-	-	-	-	-	-	-	-	-	1	1	1	1	2	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000000
72 JUTO	-	-	-	1	-	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000000
84 CLLI	-	-	-	-	-	-	-	-	1	-	1	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000000
97 MESA	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000000
109 TRPR	-	-	-	-	-	-	-	-	-	2	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000000
37 CAEX	-	-	-	2	-	1	-	-	1	1	-	1	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000001
41 EQLA	1	-	-	-	1	-	-	-	-	-	-	-	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000001
77 SOCA	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000001
88 RHTR	-	2	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000001
107 SOLID	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000001
50 GLLE	-	-	-	-	-	2	-	2	1	1	-	1	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000010
90 VEBL	-	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000011
101 POLYG	-	-	-	2	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000011
9 BIFR	1	-	-	1	1	1	2	-	1	-	1	1	3	1	1	-	1	-	3	1	1	1	-	-	-	-	-	-	1	-	1	-	-	-	000100
12 PLMA	-	-	-	4	4	1	1	-	1	1	2	2	1	1	1	1	1	1	-	1	1	-	-	2	-	-	-	-	-	-	-	-	-	-	000100
18 POPE	-	3	-	1	4	2	4	-	1	1	1	1	1	-	-	-	-	-	1	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	000100
24 HEAN	-	-	-	2	-	2	1	-	-	1	1	1	1	-	-	1	-	2	-	-	1	-	-	-	1	-	1	-	-	-	-	-	-	-	000100
30 XAST	-	-	-	4	3	1	-	-	1	-	1	1	1	-	-	1	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	000100
35 SCPU	1	-	-	1	3	-	-	-	1	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	000100
38 CAHY	1	-	1	1	-	-	-	-	-	1	-	-	1	1	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
39 ELEOC	1	-	1	1	2	-	-	-	-	-	-	-	1	1	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
43 PACA	1	-	-	1	1	-	1	-	-	1	-	-	1	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	000100
60 MEAR	-	-	-	1	1	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	000100
68 COCA	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	000100
70 ECCR	-	-	-	1	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	000100
75 PODO	-	-	-	-	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	000100
78 SOOL	-	-	-	-	-	1	1	-	1	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
91 AGROS	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
93 CASI	4	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
56 ARMI	-	1	-	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	000101
73 LEOR	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	000101
74 LYAM	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	000101
76 SCMA	-	-	1	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000101
5 MEAL	-	-	-	5	4	2	1	5	4	2	3	5	4	1	2	2	5	4	1	-	-	-	-	-	-	-	-	1	1	1	1	2	1	-	000110
14 APCA	-	-	-	-	-	1	-	1	1	3	-	1	1	2	1	1	2	1	-	-	-	-	-	-	-	-	1	-	-	-	1	1	1	-	000110
15 HEAU	-	-	-	1	2	1	1	-	1	1	1	1	-	1	2	1	2	1	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	000110
61 NECA	-	1	-	-	-	-	-	-	-	1	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	000110
2 EUOC	-	2	1	1	2	3	1	2	2	2	1	1	1	2	2	-	2	3	-	1	1	1	-	-	-	3	-	1	1	1	2	1	1	-	000111
4 SAEX	-	3	1	4	2	4	-	2	2	4	1	1	3	4	5	5	4	3	4	-	4	-	4	2	-	4	4	-	-	-	1	-	5	-	000111
27 ASCH	-	-	-	-	-	-	1	-	-	1	1	1	1	3	2	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-	1	2	-	-	000111
31 CANE	-	-	1	-	-	-	-	-	1	1	1	1	-	1	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	000111
32 MESP	-	-	-	-	-	1	1	-	1	-	1	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	000111
11 CHAL	3	5	4	1	1	1	-	-	1	1	-	-	1	-	-	-	-	-	1	1	2	2	-	-	1	1	1	-	-	-	-	-	1	-	001000
20 CIAR	1	4	-	-	-	-	-	-	1	2	-	-	1	2	1	-	-	-	-	1	1	-	-	-	1	2	1	-	-	-	-	-	4	-	001000
25 HOJU	1	-	2	-	-	-	-	-	1	1	1	1	1	-	-	-	-	-	1	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	001000
26 SCAC	-	3	2	-	1	-	-	-	-	1	1	1	-	-	1	1	-	-	-	-	2	2	1	-	-	1	-	-	-	-	-	-	-	-	001000
28 TRIFO	-	-	3	1	1	-	-	-	1	-	-	-	-	1	1	1	-	-	-	-	1	1	-	1	-	1	-	-	-	-	-	-	-	-	001000
52 SAAM	-	2	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	1	-	1	2	-	-	-	-	1	-	-	-	-	-	-	-	-	001000
58 DISP	1	-	2	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	001000
80 AGRE	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	001000
86 JUBA	2	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	001000
6 POMO	-	1	1	2	1	2	2	-	2	1	2	1	1	1	-	1	-	1	-	3	1	2	2	1	-	1	-	1	-	-	-	-	1	-	001001
22 VEAN	-	-	-	3	1	1	-	-	1	1	1	1	-	-	-	-	-	-	-	2	1	-	1	1	-	-	-	1	-	-	-	-	1	-	001001
29 URDI	-	1	-	1	-	-	-	-	1	-	-	-	-	1	-	3	-	-	-	1	1	1	-	-	-	-	1	-	-	-	-	-	1	-	001001
42 NAOF	-	-	-	-	-	-	-	-	1	1	2	1	-	-	-	-	-	-	1	2	1	-	-	2	-	-	-	-	-	-	-	-	-	-	001001
46 TAOF	-	-	-	-	-	-	1	-	-	-	1	1	-	1	-	1	-	-	-	-	-	-	-	1	-	-	-	1	1	-	-	-	-	-	001001
53 SOAS	-	-	-	-	-	-	2	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	1	-	-	001001
55 VEBR	-	-	-	1	-	1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	001001
79 TRFR	-	-	-	-	-	-	1	-	-	1	2	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	001001
82 ATPA	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	001001

Appendix 3 (continued)

	26	28	30	10	14	13	19	31	1	2	3	4	8	9	11	15	17	23	22	5	6	16	32	7	20	21	29	12	25	33	24	27	18	34	
16 PHAR	-	-	-	-	1	-	-	-	3	2	2	-	1	1	1	3	-	-	-	-	1	-	2	1	1	1	-	1	2	-	-	-	-	-	001010
33 MUAS	-	-	-	-	1	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	-	2	-	-	001010
36 ARLU	-	-	-	-	-	1	1	1	-	-	1	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	1	-	001010
57 CIDO	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	001010
59 EPILO	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001010
63 SOGI	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	1	-	001010
85 FRPE	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	001010
8 SODU	-	-	-	-	-	-	-	-	1	1	1	-	1	3	-	4	1	2	2	2	1	2	5	1	-	2	3	2	1	-	2	-	4	-	001011
19 CAREX	-	-	-	-	-	1	-	-	-	-	1	-	-	1	1	1	1	-	-	1	1	1	-	1	-	-	-	-	1	-	-	1	-	-	001011
23 EPGL	-	-	-	1	-	-	1	-	1	1	2	2	-	-	-	-	1	-	-	-	1	4	2	-	-	-	-	1	1	-	-	-	-	-	001011
40 ELPA	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-	1	-	1	1	2	-	-	-	-	-	-	-	-	-	001011
44 POPR	1	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	1	-	-	1	1	-	-	1	-	-	-	-	-	-	001011
45 RIAU	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	3	1	1	1	-	-	2	-	-	-	2	1	-	-	-	-	-	-	001011
1 DIFU	2	-	-	1	-	2	-	-	1	1	3	1	2	1	4	-	2	1	1	5	4	4	4	3	3	-	2	4	4	4	4	3	3	-	001100
7 RUCR	-	1	-	-	2	-	1	-	1	1	1	1	-	1	-	1	-	2	-	1	1	-	1	1	-	1	3	1	1	2	1	1	2	-	001100
10 LYAS	-	1	-	-	-	-	-	-	1	1	1	-	-	1	1	1	1	-	-	3	1	4	-	-	3	4	-	2	2	-	2	1	1	-	001100
54 UGRSS	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	3	-	1	-	-	-	-	-	-	-	-	2	-	001100
71 GAPA	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	1	1	-	-	-	-	1	-	-	-	001100
47 ARTR	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	1	2	2	-	-	-	1	-	001101
49 DSHRB	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	2	-	-	3	2	-	-	2	-	001101
65 VETH	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	2	1	-	-	-	001101
83 CHNA	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	2	-	-	-	1	-	001101
87 POSE	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	-	001101
98 MOSS	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	-	-	-	-	-	001101
102 PUTR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	-	-	2	-	-	001101
115 ATCA	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	001101
34 POAM	-	-	-	-	-	1	-	-	-	1	1	1	-	-	-	-	-	-	1	2	2	-	2	-	-	-	-	-	-	-	-	-	1	-	001110
64 UFORB	-	-	-	-	-	1	-	-	1	-	-	-	-	1	-	-	-	-	-	1	2	-	1	-	-	-	-	-	-	-	-	-	-	-	001110
81 ASFA	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	001110
89 UPLNT	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	001110
66 ASTER	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	1	-	-	1	-	-	-	001111
67 CIVU	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	1	-	-	-	-	-	-	001111
69 DAGL	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1	-	1	-	-	-	-	001111
106 SAKA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	2	-	-	001111
3 LASE	-	-	1	-	1	1	1	1	1	1	1	1	2	1	-	1	1	2	1	-	-	1	-	-	3	1	1	1	1	2	1	-	-	1	010
13 BRTE	1	-	-	-	-	1	1	2	-	-	-	1	1	-	-	-	-	1	1	-	-	-	-	1	-	-	1	1	1	-	1	2	2	4	010
51 ROWO	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	1	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	3	010
21 ELAN	-	-	1	-	-	-	-	-	-	1	1	-	-	-	1	1	1	1	-	4	4	-	-	1	-	3	-	-	-	-	-	4	-	4	011
62 SIAL	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1	-	5	1
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1		

Appendix 4 - Two-way indicator species analysis with plant species cover data from the Shore & Bottomland Wetland cover type, Hagerman Study Area, 1987-1990. Values in the table denote categories of abundance. Cut levels used were the default values 1, 2, 5, 10, and >20% cover. Shaded area separates classes of samples at level 1. Dashed lines separate classes of species at level 2. Species codes are defined in Appendix 11.

	4	5	7	8	9	1	2	3	6	
26 SODU	-	1	-	-	-	-	-	1	-	111
19 HOJU	1	-	-	-	-	1	-	-	-	111
17 ELAN	2	-	-	-	-	1	-	-	-	11011
4 DIFU	-	3	-	-	-	-	1	1	-	11011
74 XAST	1	-	-	-	-	-	-	-	-	110101
73 VEAN	-	1	-	-	-	-	-	-	-	110101
72 UGRAM	1	-	-	-	-	-	-	-	-	110101
70 SCPU	-	2	-	-	-	-	-	-	-	110101
69 SCMA	1	-	-	-	-	-	-	-	-	110101
68 SCGA	-	1	-	-	-	-	-	-	-	110101
67 SACU	1	-	-	-	-	-	-	-	-	110101
66 ROPA	-	1	-	-	-	-	-	-	-	110101
65 RASC	1	-	-	-	-	-	-	-	-	110101
62 POHY	1	-	-	-	-	-	-	-	-	110101
56 MALVA	-	1	-	-	-	-	-	-	-	110101
55 LYAS	-	1	-	-	-	-	-	-	-	110101
51 JUTO	1	-	-	-	-	-	-	-	-	110101
50 JUBA	-	1	-	-	-	-	-	-	-	110101
46 GAAP	-	1	-	-	-	-	-	-	-	110101
44 ELEOC	1	-	-	-	-	-	-	-	-	110101
37 CAREX	1	-	-	-	-	-	-	-	-	110101
35 CAHY	1	-	-	-	-	-	-	-	-	110101
32 BEER	1	-	-	-	-	-	-	-	-	110101
14 TYLA	3	3	2	-	-	-	-	-	-	110100
20 LEMNA	1	-	-	-	1	-	-	-	-	1100
57 MELU	-	-	1	-	-	-	-	-	-	101
2 SCAC	2	1	1	4	3	-	-	1	-	101
28 TRFR	-	-	4	-	-	1	-	-	-	1001
13 RUCR	-	-	-	3	-	1	-	1	-	1001
10 PHAR	-	-	1	1	-	-	1	-	-	1001
5 ELPA	-	-	1	1	-	-	-	1	-	1001
16 BIFR	-	-	1	-	-	1	-	-	-	1000
12 POPE	-	-	2	-	-	1	-	1	-	1000
11 PLMA	-	-	1	-	-	1	-	-	1	01
1 POMO	1	1	1	-	-	1	-	2	2	01
71 SOAS	-	-	-	-	-	1	-	-	-	00
64 POPR	-	-	-	-	-	-	1	-	-	00
63 POLYG	-	-	-	-	-	-	-	1	-	00
61 PODO	-	-	-	-	-	1	-	-	-	00
60 PLLA	-	-	-	-	-	-	2	-	-	00
59 PHAU	-	-	-	-	-	-	1	-	-	00
58 PACA	-	-	-	-	-	1	-	-	-	00
54 LYAM	-	-	-	-	-	-	-	1	-	00
53 LEPE	-	-	-	-	-	-	1	-	-	00
52 KOSC	-	-	-	-	-	-	1	-	-	00
49 IVAX	-	-	-	-	-	-	1	-	-	00
48 GRSQ	-	-	-	-	-	1	-	-	-	00
47 GLLE	-	-	-	-	-	-	1	-	-	00
45 EPPA	-	-	-	-	-	1	-	-	-	00
43 DISP	-	-	-	-	-	-	1	-	-	00
42 DESO	-	-	-	-	-	-	3	-	-	00
41 DAGL	-	-	-	-	-	-	1	-	-	00
40 CIVU	-	-	-	-	-	-	2	-	-	00
39 CIDO	-	-	-	-	-	-	-	3	-	00
38 CHAL	-	-	-	-	-	-	1	-	-	00
36 CANE	-	-	-	-	-	-	-	1	-	00
34 CAEX	-	-	-	-	-	-	-	-	1	00
33 BROMU	-	-	-	-	-	-	1	-	-	00
31 ATPA	-	-	-	-	-	1	-	-	-	00

Appendix 4 (continued)

	4	5	7	8	9	1	2	3	6	
30 ARLU	-	-	-	-	-	2	-	-	-	00
29 AGRE	-	-	-	-	-	-	2	-	-	00
27 TAOF	-	-	-	-	-	1	1	-	-	00
25 SIAL	-	-	-	-	-	1	1	-	-	00
24 SAEX	-	-	-	-	-	3	-	3	-	00
23 MESP	-	-	-	-	-	-	-	1	1	00
22 MESA	-	-	-	-	-	1	1	-	-	00
21 MEAL	-	-	-	-	-	2	-	-	2	00
18 EQAR	-	-	-	-	-	1	1	-	-	00
15 APCA	-	-	-	-	-	1	-	-	1	00
9 LASE	-	-	-	-	-	1	-	1	1	00
8 HEAU	-	-	-	-	-	1	-	1	1	00
7 HEAN	-	-	-	-	-	1	-	1	1	00
6 EUOC	-	-	-	-	-	1	-	1	4	00
3 BRTE	-	-	-	-	-	2	1	1	1	00
	0	0	0	0	0	1	1	1	1	
	0	0	1	1	1					

Appendix 5 - Two-way indicator species analysis with plant species cover data from the Scrub-Shrub Wetland cover type, Hagerman Study Area, 1987-1990. Values in the table denote categories of abundance. Cut levels used were the default values 1, 2, 5, 10, and >20% cover. Shaded area separates classes of samples at level 3. Dashed lines separate classes of species at level 2. Species codes are defined in Appendix 11.

	30	15	17	19	32	5	16	3	11	18	20	4	10	13	22	1	2	6	12	14	7	8	21	9	23	24	25	26	27	28	31	29	
3 SODU	3	4	1	5	5	2	3	2	3	1	3	2	3	1	4	4	2	3	1	3	4	-	3	1	1	1	2	-	-	-	-	-	00000
23 CHAL	-	-	5	1	-	1	-	2	1	-	1	-	1	-	-	-	1	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	00000
15 SAAM	5	4	4	3	4	3	-	3	3	-	3	-	2	-	3	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	000010
30 SCAC	4	1	1	1	-	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	000010
41 CIVU	-	1	-	1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	000010
72 KOSC	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	000010
83 BICE	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	000010
84 BROMU	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000010
91 LEMNA	5	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000010
94 PHVI	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000010
31 ARMI	-	1	-	2	-	-	-	-	-	2	-	-	-	1	-	-	1	-	4	-	-	-	-	1	-	-	-	-	-	-	-	-	000011
42 EPGL	-	2	-	-	-	1	-	-	-	-	-	1	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	000011
56 BEER	-	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000011
2 SAEX	-	5	5	5	4	4	5	5	5	-	5	5	4	3	5	5	5	5	5	5	5	5	5	5	5	-	1	-	3	-	5	-	00010
16 URDI	-	1	1	1	-	2	2	-	1	3	-	4	1	-	-	2	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	4	00010
28 GLLE	-	-	-	-	-	3	-	-	-	-	-	-	2	1	-	1	-	1	1	-	-	2	-	1	-	1	-	-	-	-	-	-	00010
1 DIFU	-	1	1	2	-	5	1	2	3	4	4	3	1	2	4	1	4	1	1	1	5	3	3	3	3	-	1	1	1	-	-	-	00011
6 EUOC	-	1	4	2	-	2	2	2	1	1	-	4	1	1	1	-	2	1	2	1	1	1	-	-	-	1	-	1	-	-	-	-	00011
18 ELAN	-	-	1	-	-	5	5	2	4	1	-	-	1	-	-	1	1	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-	00011
25 LASE	-	-	-	-	-	-	-	1	1	2	-	-	-	-	-	1	1	1	1	-	1	-	-	2	2	-	-	-	-	1	-	-	00011
10 CIAR	-	-	3	1	-	4	3	2	-	-	-	1	1	1	1	-	1	1	2	1	3	1	3	1	-	-	-	-	-	-	-	-	0010
13 LYAS	-	2	-	1	-	1	2	4	3	3	1	1	1	-	-	1	1	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	0010
14 PHAR	1	-	-	-	-	1	1	1	-	-	1	1	1	1	1	2	1	1	-	1	1	1	-	-	-	-	-	-	-	-	-	-	0010
66 VEAN	-	1	-	-	-	1	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0010
36 SOCA	-	-	-	-	-	-	-	1	-	-	-	1	-	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001100
45 ASOF	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	001100
46 ASTER	-	-	-	-	-	1	-	-	1	-	-	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001100
63 SIAL	-	-	-	-	-	1	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	001100
74 MESP	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	001100
76 POPE	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001100
9 RUCR	-	-	1	-	-	-	-	2	2	1	3	2	1	1	1	1	1	1	1	1	1	1	1	-	2	-	-	-	-	-	-	-	001101
61 LEOR	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001101
73 MEAR	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001101
49 COMPO	-	-	-	-	-	1	-	1	1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001110
70 ELPA	-	-	-	-	-	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001110
71 GAAP	-	-	-	-	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001110
75 NAOF	-	-	-	-	-	-	2	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001110
37 UFORB	-	-	-	-	-	-	1	1	-	1	1	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001111
85 CAHY	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001111
86 DEPI	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001111
98 SAVE	-	-	-	-	-	-	-	-	1	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	001111
22 BIFR	-	-	-	1	-	-	-	1	1	1	-	-	-	-	-	1	3	1	-	2	1	-	-	1	2	-	-	-	-	-	-	-	010000
32 CAREX	-	-	1	-	-	1	1	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	010000
24 EQAR	-	-	-	-	-	1	-	1	-	-	1	1	-	1	-	1	1	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	010001
26 POMO	-	-	-	-	-	-	3	-	1	-	-	1	1	-	-	1	1	1	1	-	1	1	-	1	-	-	-	-	-	-	-	-	010001
33 COMA	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	1	-	-	1	1	2	-	-	-	-	-	-	-	010001
35 PLMA	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1	1	-	1	1	-	-	-	2	-	-	-	-	-	-	-	-	010001
43 EPILO	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	1	1	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	010001
47 CIDO	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	2	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	010001
52 LYAM	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	010001
57 CAEX	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	010001
58 CANE	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	010001
59 HOJU	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	010001
67 AGST	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	010001
82 BEOC	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	010001
88 ECLO	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	010001
97 ROPA	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	010001
106 VETH	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	010001
17 APCA	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	1	3	2	3	3	-	1	1	2	2	1	-	-	-	-	-	-	010010

Appendix 5 (continued)

	30	15	17	19	32	5	16	3	11	18	20	4	10	13	22	1	2	6	12	14	7	8	21	9	23	24	25	26	27	28	31	29	
39 ASCH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	2	2	1	1	-	-	-	-	-	-	-	-	-	010010
44 HEAU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	1	-	1	-	1	-	-	-	-	-	-	-	-	010010
48 COCA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	1	-	-	-	-	-	-	-	010010
55 ARLU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	2	3	-	-	-	-	-	-	-	-	-	010010
77 TAOF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	010010
78 TRIFO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	010010
79 AMAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	010010
80 ASHE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	010010
81 ATCA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	010010
90 GRSQ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	010010
92 MESA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	010010
93 OEHO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	010010
95 POHY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	010010
100 SOLID	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	010010
19 NECA	-	1	-	1	-	1	-	-	-	-	1	1	-	1	-	1	3	1	1	-	1	-	2	-	-	-	-	-	-	-	-	-	010011
51 FRPE	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	010011
54 XAST	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	010011
29 EQLA	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1	1	1	1	-	1	-	-	-	-	1	-	-	-	-	-	0101
11 MEAL	-	-	-	-	-	-	-	-	1	-	-	-	2	1	-	1	-	3	2	1	3	3	3	3	1	-	1	2	-	2	2	-	011
34 HEAN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	1	-	1	-	-	-	1	-	1	-	-	100
27 CERE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	2	-	1	-	-	-	4	3	3	-	5	4	-	10100
60 IVAX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	-	2	-	-	10100
69 CLLI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	2	10100
89 GAPA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	10101
96 POSE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	10101
21 ARTR	-	-	-	-	-	-	-	-	1	1	-	1	-	1	-	1	-	1	1	-	-	1	-	-	1	3	3	-	-	-	-	-	1011
40 ASSP	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	1	1	-	-	-	1011
53 POPR	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	1	-	-	-	1011
50 ELCI	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	11000
87 DESO	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	11000
4 BRTE	-	-	-	-	-	-	-	1	-	2	1	1	1	1	1	1	1	1	1	-	-	1	1	1	1	1	1	2	-	2	2	1	11001
62 SAKA	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	11001
68 CHNA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	11001
5 DSHRB	3	4	1	2	-	-	-	2	2	3	-	1	3	3	2	-	-	2	1	2	3	-	1	-	-	2	-	-	3	4	3	2	1101
7 RIAU	-	3	1	1	-	1	-	1	3	4	1	3	3	-	2	1	-	2	-	1	1	-	-	-	-	3	3	1	3	-	-	4	1101
8 RHTR	-	-	3	-	-	4	-	3	4	4	-	5	3	5	1	1	-	5	-	-	-	-	-	-	-	5	5	5	5	3	5	1	1101
20 TORA	-	-	-	-	3	-	-	-	-	-	-	1	1	-	2	1	-	2	1	2	-	-	-	-	-	2	3	-	1	-	-	5	1101
12 ROWO	-	5	1	3	5	4	-	-	-	2	4	-	3	3	1	-	1	-	-	-	1	-	-	-	-	-	4	2	5	-	-	1	111
38 AGRE	-	1	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	111
64 SMST	-	-	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	111
65 SOGI	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	-	-	-	-	111
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	
	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	
	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1		

Appendix 6 - Two-way indicator species analysis with plant species cover data from the Forested Wetland cover type, Hagerman Study Area, 1987-1990. Values in the table denote categories of abundance. Cut levels used were the default values 1, 2, 5, 10, and >20% cover. Shaded area separates classes of samples at level 3. Dashed lines separate classes of species at level 2. Species codes are defined in Appendix 11.

	1	2	3	4	5	6	7	8	9	10	
12 SAAM	5	5	5	5	-	-	-	-	-	-	00
13 AGRE	1	1	-	1	-	-	-	-	-	-	00
15 CAREX	1	-	1	1	-	-	-	-	-	-	00
16 ELAN	2	4	3	-	-	-	-	-	-	-	00
18 LEMNA	3	1	-	1	-	-	-	-	-	-	00
19 LYAS	2	1	-	1	-	-	-	-	-	-	00
21 PHAR	1	1	-	1	-	-	-	-	-	-	00
23 ARMI	-	-	2	1	-	-	-	-	-	-	00
24 DTREE	1	-	-	1	-	-	-	-	-	-	00
25 EPGL	1	1	-	-	-	-	-	-	-	-	00
27 POPR	-	1	1	-	-	-	-	-	-	-	00
28 SCAC	1	-	-	1	-	-	-	-	-	-	00
29 TYLA	1	-	-	2	-	-	-	-	-	-	00
30 URDI	-	1	-	1	-	-	-	-	-	-	00
5 ROWO	4	2	4	5	2	1	1	-	-	-	0100
7 DIFU	1	5	1	2	1	-	1	-	-	-	0100
8 SAEX	1	3	5	1	1	1	-	-	-	-	0100
9 SODU	3	2	5	5	1	-	1	-	-	-	0100
14 APCA	3	-	1	-	-	1	-	-	-	-	0100
10 EUOC	3	1	1	2	-	-	-	1	-	-	0101
20 MOSS	-	1	-	1	1	-	-	-	-	-	011
3 DSHRB	1	4	2	-	1	3	-	1	1	-	100
11 TORA	-	-	5	3	5	2	3	-	-	-	100
22 AGST	-	1	-	-	-	1	-	-	-	-	100
2 RIAU	4	1	-	2	1	4	4	-	4	4	101
4 RHTR	3	1	1	3	5	5	5	-	-	-	101
17 FRPE	1	-	-	-	1	-	1	-	-	-	101
1 BRTE	1	1	-	-	2	2	1	2	1	1	11
6 CERE	-	-	-	-	5	5	5	5	5	5	11
26 MEAL	-	-	-	-	-	-	-	1	1	-	11
31 VIVI	-	-	-	-	-	1	3	-	-	-	11
	0	0	0	0	1	1	1	1	1	1	
					0	0	0	1	1	1	

Appendix 7 - Two-way indicator species analysis with plant species cover data from the Shrubland cover type, Hagerman Study Area, 1987-1990. Values in the table denote categories of abundance. Cut levels used were the default values 1, 2, 5, 10, and >20% cover. Shaded area separates classes of samples at level 3. Dashed lines separate classes of species at level 2. Species codes are defined in Appendix 11.

					1	1	1		1	2	2				1	1	1	1	1	1	2	2		
	1	2	3	5	0	2	4	8	5	1	3	4	6	7	9	1	6	8	3	7	0	2	9	
20 MEAL	5	4	5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
26 APCA	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
30 PLMA	1	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
38 COCA	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
44 HEAU	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
48 LYAS	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
55 PUTR	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
62 XAST	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
65 ARBI	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
70 ASTER	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
71 BAHY	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
72 BIFR	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
73 CAEX	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
79 CUSCU	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
86 GRSQ	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
87 MACA	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
88 MAVU	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
89 MEAR	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
90 MELIL	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
97 POLYG	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
104 SOGI	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
109 ULPI	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00000
15 EQAR	2	1	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	00001
9 EUOC	3	2	2	2	1	-	-	-	4	-	-	1	1	-	-	-	-	-	-	-	-	-	-	000100
22 RUCR	-	1	-	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	000100
32 VETH	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
54 POMO	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000101
61 VEBR	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000101
14 GLLE	3	3	3	-	-	-	-	1	-	-	-	-	-	-	-	2	-	5	-	-	-	-	-	00011
42 FRPE	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	00011
43 HEAN	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	00011
60 URDI	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	00011
3 SAEX	5	1	5	5	-	-	-	5	-	4	-	5	5	5	4	1	-	5	-	-	-	-	-	0010
41 EQLA	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	0010
59 UPLNT	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	0010
8 DIFU	4	-	1	-	-	4	2	-	1	-	-	1	2	3	-	-	-	-	-	-	-	-	-	00110
18 UGRSS	1	-	-	1	1	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	00110
6 SODU	1	1	-	4	-	-	-	2	-	2	3	1	1	1	-	1	-	-	-	-	-	-	-	00111
27 ASSP	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00111
33 AGROS	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00111
5 RIAU	-	2	1	1	1	-	-	1	-	1	-	1	1	2	3	1	-	-	-	-	-	-	-	0100
23 SAAM	-	-	1	-	-	-	-	-	-	-	-	1	-	3	-	4	-	-	-	-	-	-	-	0100
35 CERE	-	1	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	0100
24 TORA	-	-	-	-	-	-	-	1	-	-	-	3	5	3	-	-	-	-	-	-	-	-	-	010100
50 MOAL	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	010100
63 AGDA	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	010100
69 ASOF	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	010100
77 CLLI	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	010100
93 NICA	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	010100
110 ULPU	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	010100
12 RHTR	-	1	-	-	-	1	-	-	-	-	-	-	1	-	5	5	5	5	-	-	-	-	-	010101
47 KOSC	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	010101
66 ARLU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	010101
68 ASHE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	010101
91 MOSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	010101
96 PODE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	010101
10 ROWO	1	-	-	-	-	-	-	1	3	3	-	4	5	-	-	2	-	4	-	-	-	-	-	01011

Appendix 7 (continued)

	1	2	3	5	10	12	14	8	15	21	23	4	6	7	19	11	16	18	13	17	20	22	9	
4 ELAN	-	-	3	5	5	5	5	5	5	5	5	2	-	-	5	-	-	-	-	-	-	-	-	01100
19 CAREX	1	-	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	01100
21 PHAR	-	-	-	1	-	-	1	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	01100
39 ELCI	-	-	-	1	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	01100
37 CIAR	-	-	-	-	-	-	-	-	5	-	-	1	-	-	-	-	-	-	-	-	-	-	-	011010
51 NECA	-	-	-	-	-	-	-	-	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-	011010
76 CIVU	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	011010
80 DESO	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	011010
83 GAPA	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	011010
13 DISP	-	-	-	-	2	-	3	1	1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	011011
28 CHAL	-	-	-	-	5	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	011011
45 HOJU	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	011011
74 CANU2	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	011011
94 PACA	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	011011
31 POPR	-	-	-	-	-	1	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	01110
34 ARMI	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	01110
40 ELTR	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	01110
46 IVAX	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	01110
25 AGRE	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	01111
53 PHVI	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	01111
36 CHNA	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	10000
75 CASC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	10000
78 COMPO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	10000
84 GISI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	10000
92 NAAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	10000
95 PEAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	10000
7 ARTR	-	5	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	5	5	5	5	4	100010
17 SIAL	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	2	-	1	100010
29 DESCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	100010
49 MEAL1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	100010
16 POSE	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	1	3	-	100011
52 PHLOX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	100011
58 UFORB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	100011
64 AMRE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	100011
67 ASCH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	100011
81 ERCI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	100011
82 ERTR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	100011
85 GRSP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	100011
1 BRTE	1	1	-	1	-	2	1	-	-	2	-	1	1	2	1	1	2	-	2	4	2	3	4	1001
56 SAVE	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	1001
2 DSHRB	1	2	1	1	-	-	-	2	-	-	-	3	1	1	3	1	1	-	2	3	-	1	2	101
57 TRDU	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	101
11 LASE	1	1	-	2	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	1	11
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	
	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	
					0	0	0	0	0	0	0	1	1	1	1	1	1	1						

Appendix 8 - Two-way indicator species analysis with plant species cover data from the Shrub Savanna cover type, Hagerman Study Area, 1987-1990. Values in the table denote categories of abundance. Cut levels used were the default values 1, 2, 5, 10, and >20% cover. Shaded area separates classes of samples at level 3. Dashed lines separate classes of species at level 2. Species codes are defined in Appendix 11.

	16	17	18	22	23	6	1	10	7	13	3	4	5	2	11	15	19	20	21	24	8	9	12	14	
29 IVAX	2	1	-	-	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	0000
40 GAPA	-	-	1	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	0000
48 RHTR	-	2	-	-	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	0000
16 ROWO	-	1	3	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
21 CIAR	-	4	5	-	5	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	000100
23 ELAN	5	-	5	5	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
24 ELCI	-	4	-	4	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	000100
10 DISP	3	1	1	-	-	1	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	000101
68 PACA	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00011
33 TORA	-	2	-	-	-	3	-	-	-	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-	0010
41 GRSQ	-	-	-	-	-	3	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	0010
53 AGRE	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	0010
72 SOGI	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	0010
20 CERE	-	-	-	-	-	3	-	-	-	2	2	-	-	1	-	-	-	-	-	-	-	-	-	-	0011
8 EUOC	-	-	4	-	-	-	3	-	1	1	1	2	1	1	-	-	-	-	-	-	-	-	-	-	0100
32 SODU	-	-	-	2	-	-	3	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-	0100
36 ASSP	-	-	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	0100
65 KOSC	1	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0100
5 DIFU	2	-	1	-	2	-	1	-	3	1	1	1	-	4	-	-	-	-	-	-	-	-	-	-	01010
15 RIAU	-	-	-	1	-	1	-	-	-	-	1	2	-	3	-	-	-	-	-	-	-	-	-	-	01010
45 PHAR	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	01010
51 VETH	-	-	-	-	-	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	01010
12 SAEX	-	-	-	4	2	-	-	4	4	5	1	-	2	-	-	-	-	-	-	-	-	-	-	-	01011
25 EQAR	1	-	-	-	-	-	1	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	01011
35 XAST	-	-	-	-	-	-	2	3	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	011000
37 BIFR	-	-	-	-	-	-	2	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	011000
38 CIVU	-	-	-	-	-	-	2	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	011000
43 LYAS	-	-	-	-	-	-	2	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	011000
46 POMO	-	-	-	-	-	-	4	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	011000
47 POPE	-	-	-	-	-	-	2	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	011000
56 ASTER	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	011000
58 CAHY	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	011000
60 CHAL	-	-	-	-	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	011000
61 ECCR	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	011000
62 EPGL	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	011000
66 MEAR	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	011000
17 RUCR	-	-	-	-	-	-	2	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	011001
26 EQLA	-	-	-	-	-	-	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	011001
34 UGRSS	-	-	-	-	-	-	1	-	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	011001
6 MEAL	-	-	-	-	-	1	1	1	5	4	2	2	1	2	-	-	-	-	-	-	-	-	-	-	011010
11 LASE	-	-	-	-	-	-	1	-	2	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	011010
19 ARLU	-	-	-	-	-	1	-	-	1	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	011010
27 GLLE	-	-	-	-	-	1	-	-	-	-	4	3	4	-	-	-	-	-	-	-	-	-	-	-	011010
31 PLMA	-	-	-	-	-	-	1	-	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	011010
42 HEAU	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	011010
54 APCA	-	-	-	-	-	-	-	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	011010
71 SOCA	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	011010
39 FRPE	-	-	-	-	-	-	-	-	-	-	-	1	1	2	-	-	-	-	-	-	-	-	-	-	011011
55 ASHE	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	011011
59 CAREX	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	011011
69 PUTR	-	-	-	-	-	-	-	-	-	-	-	-	-	4	3	-	-	-	-	-	-	-	-	-	0111
3 DSHRB	-	1	-	-	-	-	-	-	-	2	1	2	-	2	2	2	1	5	-	-	2	1	-	-	10
4 ARTR	-	-	-	-	-	-	3	-	-	1	3	2	-	-	4	4	2	4	3	-	-	1	-	-	10
50 UFORB	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-	10
13 ASCH	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	1	-	-	1	1	1	1100
28 GRSP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	4	-	2	2	110100
44 PEAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	110100
49 SIHY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	110100

Appendix 8 (continued)

	16	17	18	22	23	6	1	10	7	13	3	4	5	2	11	15	19	20	21	24	8	9	12	14	
57 ATCA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	110100
63 FRAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	110100
64 GISI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	110100
67 NAAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	110100
73 STCO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	1	110100
2 CHNA	-	-	-	-	-	-	1	-	-	1	-	-	-	2	1	-	-	3	3	4	2	4	3	1	110101
30 ORHY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	1	-	11011
52 VUOC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	-	11011
7 SIAL	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	4	-	1	1	-	1	2	4	3	11100
14 CHVI	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	5	-	1	-	1	1	-	3	11100
18 SAKA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	1	-	-	-	-	-	-	3	11100
9 POSE	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	1	2	2	-	1	1	1	-	-	11101
22 DESCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	1	1	-	-	11101
70 RATE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	11101
1 BRTE	1	1	-	2	1	2	1	-	-	1	2	1	2	1	2	4	4	3	4	4	4	2	3	4	1111
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	
	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	
	0	0	0	0	0	1	0	0	1	1	1	1	1	1					0	0	0	0	0	1	

Appendix 9 - Two-way indicator species analysis with plant species cover data from the Forbland cover type, Hagerman Study Area, 1987-1990. Values in the table denote categories of abundance. Cut levels used were the default values 1, 2, 5, 10, and >20% cover. Shaded area separates classes of samples at level 3. Dashed lines separate classes of species at level 2. Species codes are defined in Appendix 11.

	5	2	4	1	3	6	8	7	
35 AGEX	1	-	-	-	-	-	-	-	000000
37 AGSM	1	-	-	-	-	-	-	-	000000
38 AGST	3	-	-	-	-	-	-	-	000000
43 BRIN	1	-	-	-	-	-	-	-	000000
44 BROMU	1	-	-	-	-	-	-	-	000000
48 CUSCU	2	-	-	-	-	-	-	-	000000
50 DISP	4	-	-	-	-	-	-	-	000000
55 ERTR	1	-	-	-	-	-	-	-	000000
58 IVXA	2	-	-	-	-	-	-	-	000000
66 RASC	1	-	-	-	-	-	-	-	000000
76 TAOF	1	-	-	-	-	-	-	-	000000
77 TRFR	3	-	-	-	-	-	-	-	000000
16 HOJU	1	-	-	1	-	-	1	-	000001
19 XAST	4	3	2	-	-	-	-	-	00001
28 PLMA	1	2	-	-	-	-	-	-	00001
7 POMO	1	1	1	1	-	-	-	-	0001
1 DIFU	2	1	3	5	5	2	-	-	001
3 LASE	1	3	2	1	1	-	-	-	001
5 CHAL	-	-	2	1	4	-	5	-	010000
13 CAREX	-	-	3	1	-	-	2	-	010001
32 UPLNT	-	-	-	1	-	-	2	-	010001
72 SCAM	-	-	-	-	-	-	4	-	010001
79 UGRSS	-	-	-	-	-	-	2	-	010001
2 EUOC	-	5	3	1	2	1	-	-	010010
6 MEAL	-	5	5	1	-	2	-	-	010010
20 AGROS	-	1	1	-	-	-	-	-	010010
23 BICE	-	-	3	-	1	-	-	-	010010
25 ELEOC	-	1	2	-	-	-	-	-	010010
27 HEAU	-	1	1	-	-	-	-	-	010010
39 APCA	-	-	1	-	-	-	-	-	010010
41 ASHE	-	2	-	-	-	-	-	-	010010
47 COCA	-	1	-	-	-	-	-	-	010010
49 DESCU	-	1	-	-	-	-	-	-	010010
53 EQAR	-	2	-	-	-	-	-	-	010010
54 EQLA	-	1	-	-	-	-	-	-	010010
56 GRSQ	-	1	-	-	-	-	-	-	010010
61 PACA	-	1	-	-	-	-	-	-	010010
74 SIAL	-	1	-	-	-	-	-	-	010010
75 SOGI	-	-	2	-	-	-	-	-	010010
78 TRPR	-	1	-	-	-	-	-	-	010010
82 VEBL	-	1	-	-	-	-	-	-	010010
83 VEBR	-	1	-	-	-	-	-	-	010010
4 BIFR	-	1	1	1	1	-	-	-	010011
9 SAEX	-	1	2	-	3	1	-	-	010011
11 BEER	-	-	3	1	1	-	-	-	010011
17 LYAS	-	-	2	1	1	-	-	-	010011
26 HEAN	-	1	-	1	-	-	-	-	010011
29 POPE	-	-	1	1	-	-	-	-	010011
30 POTEN	-	1	-	1	-	-	-	-	010011
33 VEAN	-	-	1	-	1	-	-	-	010011
22 BAHY	-	-	-	-	3	-	1	-	01010
34 VETH	-	1	-	2	-	-	-	-	01010
10 ASTER	-	1	-	2	1	-	-	-	010110
8 RUCR	-	1	-	1	2	3	-	-	010111
18 SODU	-	-	-	1	4	2	-	-	010111
21 ARLU	-	-	-	2	-	4	-	-	010111
24 CIDO	-	-	-	2	2	-	-	-	010111
31 SCAC	-	-	-	1	1	-	-	-	010111

Appendix 9 (continued)

	5	2	4	1	3	6	8	7	
36 AGRE	-	-	-	-	-	1	-	-	010111
40 ASFA	-	-	-	1	-	-	-	-	010111
42 ASSP	-	-	-	-	-	1	-	-	010111
45 CAHY	-	-	-	-	1	-	-	-	010111
46 CIAR	-	-	-	-	-	3	-	-	010111
51 EPGL	-	-	-	2	-	-	-	-	010111
59 LYAM	-	-	-	-	1	-	-	-	010111
60 MEAR	-	-	-	1	-	-	-	-	010111
62 PHAR	-	-	-	1	-	-	-	-	010111
63 PHVI	-	-	-	-	-	1	-	-	010111
65 RANUN	-	-	-	-	1	-	-	-	010111
67 RORIP	-	-	-	-	1	-	-	-	010111
68 RUMA	-	-	-	-	1	-	-	-	010111
69 RUMEX	-	-	-	1	-	-	-	-	010111
70 SAAM	-	-	-	-	1	-	-	-	010111
71 SAKA	-	-	-	1	-	-	-	-	010111
73 SCGA	-	-	-	-	1	-	-	-	010111
80 ULPU	-	-	-	-	1	-	-	-	010111
81 URDI	-	-	-	-	1	-	-	-	010111
14 CHNA	-	-	-	2	-	1	-	1	011
15 DSHRB	1	-	-	-	-	1	-	1	10
12 BRTE	-	1	-	-	-	1	-	4	11
52 EPILO	-	-	-	-	-	-	-	1	11
57 GUSA	-	-	-	-	-	-	-	4	11
64 POSE	-	-	-	-	-	-	-	2	11
84 VUOC	-	-	-	-	-	-	-	1	11
	0	0	0	0	0	0	0	1	
	0	1	1	1	1	1	1		

Appendix 10- Two-way indicator species analysis with plant species cover data from the Desertic Herbland cover type, Hagerman Study Area, 1987-1990. Values in the table denote categories of abundance. Cut levels used were the default values 1, 2, 5, 10, and >20% cover. Shaded area separates classes of samples at level 1. Dashed lines separate classes of species at level 2. Species codes are defined in Appendix 11.

	2	4	5	6	1	3	
1 BRTE	3	1	2	3	1	-	00
3 SIAL	1	1	-	3	-	-	01
5 ASTRA	1	1	-	-	-	-	01
7 CHDO	1	1	-	-	-	-	01
8 CHNA	2	3	-	-	-	-	01
9 DSHRB	2	2	-	-	-	-	01
12 AGEX	-	-	1	-	-	-	01
15 APCA	-	-	-	1	-	-	01
19 CASC	-	1	-	-	-	-	01
20 CASI	-	-	1	-	-	-	01
24 DISP	-	-	3	-	-	-	01
26 ERVI	-	1	-	-	-	-	01
27 FRAC	1	-	-	-	-	-	01
28 GISI	-	1	-	-	-	-	01
31 JUBA	-	-	1	-	-	-	01
32 KOSC	-	-	2	-	-	-	01
33 MEAL1	-	1	-	-	-	-	01
34 MOSS	-	-	1	-	-	-	01
35 MUAS	-	-	-	1	-	-	01
38 PEAC	2	-	-	-	-	-	01
39 PHHA	-	1	-	-	-	-	01
40 PHLOX	2	-	-	-	-	-	01
42 POPR	-	-	1	-	-	-	01
45 SAKA	-	-	-	1	-	-	01
47 TRDU	1	-	-	-	-	-	01
48 UFORB	1	-	-	-	-	-	01
50 UPLNT	1	-	-	-	-	-	01
10 EUOC	-	-	-	-	2	2	100
13 AGROP	-	-	-	-	-	1	100
14 AGROS	-	-	-	-	-	1	100
16 ASCH	-	-	-	-	1	-	100
17 ASHE	-	-	-	-	-	2	100
18 CAREX	-	-	-	-	-	1	100
21 CIDO	-	-	-	-	-	1	100
22 COCA	-	-	-	-	1	-	100
23 DIFU	-	-	-	-	1	-	100
25 EQLA	-	-	-	-	1	-	100
29 GLLE	-	-	-	-	3	-	100
30 HEAN	-	-	-	-	1	-	100
36 OEHO	-	-	-	-	1	-	100
37 ORHY	-	-	-	-	-	1	100
41 PLLA	-	-	-	-	-	1	100
43 RIAU	-	-	-	-	1	-	100
44 SAEX	-	-	-	-	-	1	100
46 TAOF	-	-	-	-	-	1	100
49 UGRSS	-	-	-	-	-	2	100
2 MEAL	1	-	-	1	2	1	101
4 ARTR	-	-	1	-	1	-	11
6 CHAL	-	-	1	-	1	-	11
11 LASE	-	-	-	1	1	-	11
	0	0	0	0	1	1	

Appendix 11. Aquatic and terrestrial species occurring in the Hagerman Study Area, arranged alphabetically by family, followed by the field code, life-form (Soil Conservation Service 1980), and wetland status (Reed 1988) and common name. Superscripts refer to taxonomic changes not noted in Hitchcock and Cronquist (1973). NI = no information available.

Family	Species	Species Code	Life-form	Common Name
ACERACEAE	*Acer negundo*	ACNE	IT	box elder
	Acer saccharinum	ACSA	IT	silver maple
ALISMACEAE[1]	*Alisma plantago-aquatica*	ALPL	PNEF	American waterplantain
	Sagittaria cuneata	SACU	PNEF	duckpotato, arrowhead
AMARANTHACEAE	*Amaranthus*	AMARA		
	Amaranthus albus	AMAL	ANF	white pigweed
	Amaranthus californicus	AMCA	ANF	California amaranth
	Amaranthus powellii	AMPO	ANF	Powell amaranth
	Amaranthus retroflexus	AMRE	AIF	
ANACARDIACEAE	*Rhus trilobata*	RHTR	NS	skunkbrush
	Toxicodendron radicans[2]	TORA	NS	poison ivy
APIACEAE[43]	*Berula erecta*	BEER	PIF	stalky berula
	Cicuta douglasii	CIDO	PNF	western water hemlock
	Conium maculatum	COMA	BIF	poison hemlock
	Cymopterus acaulis	CYAC	PNF	stemless spring parsley
	Cymopterus petraeus	CYPE	PNF	stone spring parsley
	Daucus carota	DACA	BIF	wild carrot
	Lomatium dissectum	LODI	PNF	fernleaf biscuitroot
	Lomatium foeniculaceum	LOFO	PNF	desert biscuitroot
	Lomatium triternatum	LOTR	PNF	nineleaf biscuitroot
	Pastinaca sativa	PASA	PIF	garden parsnip
	Sium suave	SISU	PNF	hemlock water-parsnip
APOCYNACEAE	*Apocynum cannabinum*	APCA	PNF	indianhemp, dogbane
ASCLEPIADACEAE	*Asclepias cryptoceras*	ASCR	PNF	pallid milkweed

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Asclepias fascicularis	ASFA	PNF	Mexican whorled milkweed
	Asclepias incarnata	ASIN	PIF?	swamp milkweed
	Asclepias speciosa	ASSP	PNF	showy milkweed
	Asclepias tuberosa	ASTU	PIF	butterfly weed
ASTERACEAE[8]	*Achillea millefolium*	ACMI	PNF	common yarrow
	Ambrosia acanthicarpa	AMAC	ANF	bursage, ragweed
	Ambrosia artemisiifolia	AMAR	ANF	annual ragweed
	Antennaria dimorpha	ANDI	PNF	low pussytoes
	Arctium lappa?	ARLA	BIF	great burdock
	Arctium minus	ARMI	BIF	common burdock
	Artemisia biennis	ARBI	AIF	biennial sagewort
	Artemisia dracunculus	ARDR	PNF	herbaceous sagewort
	Artemisia ludoviciana	ARLU	PNF	Louisiana sagewort
	Artemisia spinescens	ARSP	NS	bud sagebrush
	Artemisia tridentata	ARTR	NS	big sagebrush
	Aster	ASTER		aster
	Aster foliaceus[47]	ASFO	PNF	
	Aster eatonii	ASEA	PNF	Eaton's aster
	Aster ericoides[9]	ASER	PNF	heath-leaved aster
	Aster hesperius	ASHE	PNF	siskiyou aster
	Balsamorhiza sagittata	BASA	PNF	arrowleaf balsamroot
	Bidens	BIDEN		beggarticks
	Bidens cernua	BICE	ANF	nodding beggarticks
	Bidens frondosa	BIFR	ANF	devil's beggarticks
	Brickellia microphylla	BRMI	NS	littleleaf brickellbush
	Carduus nutans	CANU2	BIF	musk thistle
	Centaurea	CENTA		knapweed
	Centaurea diffusa	CEDI	AIF	diffuse knapweed
	Centaurea repens	CERE2	AIF	Russian knapweed
	Chaenactis douglasii	CHDO	BNF	Douglas dusky maiden
	Chondrilla juncea	CHJU	PIF	rush skeletonweed

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Chrysothamnus nauseosus	CHNA	NS	rubber rabbitbrush
	Chrysothamnus viscidiflorus	CHVI	NS	tall green rabbitbrush
	Cichorium intybus	CIIN	PIF	chicory
	Cirsium arvense	CIAR	PIF	Canada thistle
	Cirsium vulgare	CIVU	BIF	bull thistle
	Conyza canadensis	COCA	ANF	horseweed
	Crepis acuminata	CRAC	PNF	tapertip hawksbeard
	Crepis modocensis	CRMO	PNF	common hawksbeard
	Crepis occidentalis	CROC	PNF	western hawksbeard
	Erigeron poliospermus	ERPO	PNF	cushion fleabane
	Erigeron pumilus	ERPU	ANF	low fleabane
	Eriophyllum lanatum	ERLA	PNF	woolly eriophyllum
	Euthamia occidentalis[12]	EUOC	PNF	western goldenrod
	Gnaphalium chilense	GNCH	AIF	cottonbatting cudweed
	Gnaphalium palustre	GNPA	ANF	lowland cudweed
	Grindelia squarrosa	GRSQ	BNF	curlycup gumweed
	Gutierrezia sarothrae	GUSA	NHS	snakeweed
	Helenium autumnale	HEAU	PNF	common sneezeweed
	Helianthus annuus	HEAN	ANF	common sunflower
	Helianthus nuttallii	HENU	PNF	Nuttall's sunflower
	Iva axillaris	IVAX	PNF	povertyweed
	Iva xanthifolia	IVXA	ANF	marshelder
	Lactuca serriola	LASE	BIF	prickly lettuce
	Lactuca tatarica[10]	LATA	PNF	beautiful prickly lettuce
	Lygodesmia juncea	LYJU	PNF	rush skeletonweed
	Machaeranthera canescens	MACA	BNF	hoary machaeranthera
	Malacothrix sonchoides[11]	MASO	ANF	desert dandelion
	Matricaria maritima	MAMA	APIF	scentless may-weed
	Solidago	SOLID		goldenrod
	Solidago canadensis	SOCA	PNF	Canada goldenrod
	Solidago gigantea	SOGI	PNF	giant goldenrod
	Sonchus	SONCH		sowthistle

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Sonchus asper	SOAS	AIF	spiny sowthistle
	Sonchus oleraceus	SOOL	AIF	annual sowthistle
	Stephanomeria exigua	STEX	ANF	small wirelettuce
	Stephanomeria tenuifolia	STTE	ANF	narrow leaved skeletonweed
	Tanacetum vulgare	TAVU	PIF	tansy
	Taraxacum officinale	TAOF	PIF	dandelion
	Tetradymia canescens	TECA2	NS	gray horsebrush
	Tetradymia glabrata	TEGL	NS	little-leaf horsebrush
	Tetradymia spinosa	TESP	NS	spiny horsebrush
	Townsendia florifer	TOFL	ABPNF	showy townsendia
	Townsendia leptotes	TOLE	PNF	common townsendia
	Tragopogon dubius	TRDU	ABIF	salsify
	Xanthium strumarium	XAST	AND	heartleaf cocklebur
BETULACEAE	*Betula occidentalis*	BEOC	NT	water birch
BIGNONIACEAE	*Catalpa speciosa*	CASP	IT	catalpa
BORAGINACEAE	*Amsinckia retrorsa*	AMRE	ANF	rough fiddleneck
	Amsinckia menziesii	AMME	ANF	Menzies fiddleneck
	Asperugo procumbens	ASPR	AIF	madwort
	Cryptantha circumscissa	CRCI	ANF	matted cryptantha
	Cryptantha fenderli	CRFE	ANF	Fendler's cryptantha
	Cryptantha interrupta	CRIN	PNF	invested cryptantha
	Cryptantha pterocarya	CRPT	ANF	winged cryptantha
	Cryptantha watsonii	CRWA	ANF	Watson cryptantha
	Cynoglossum officinale	CYOF	BIF	houndstongue
	Lappula redowskii	LARE	AIF	Redowski tickweed
	Tiquilia nuttallii[3]	TINU	ANF	Nuttall's coldenia
BRASSICACEAE[14]	*Brassica nigra*	BRNI	AIF	black mustard
	Camelina microcarpa	CAMI	AIF	smallseed falseflax

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Capsella bursa-pastoris	CABU	AIF	shepherd's purse
	Caulanthus crassicaulis	CACR	PNF	thickstem wild cabbage
	Chorispora tenella	CHTE	AIF	blue mustard
	Conringia orientalis	COOR	AIF	treacle hares' ear
	Descurainia sophia-pinnata	DESO	AIF	flixweed
	Descurainia richardsonii	DERI	BNF	Richardson tansy mustard
	Erophila verna[15]	ERVE	AIF	spring whitlow-grass
	Erysimum asperum	ERAS	AIF	asperum wallflower
	Erysimum inconspicuum	ERIN	PNF	smallflower wallflower
	Erysimum repandum	ERRE	AIF	bushy wallflower
	Lepidium latifolium	LELA	AIF	perennial pepperweed
	Lepidium perfoliatum	LEPE	ABNF	yellowflower pepperweed
	Nasturtium officinale[16]	NAOF	AIF	watercress
	Rorippa palustris[44]	ROPA	ANF	yellowcress
	Sisymbrium altissimum	SIAL	ABIF	tall tumble mustard
	Stanleya pinnata	STPI	NHS	desert princesplume
	Streptanthella longirostris	STLO	ANF	longbeak streptanthella
	Thelypodium laciniatum	THLA	BNF	cutleaved thelypody
	Thelypodium integrifolium	THIN	BNF	entireleaved thelypody
CACTACEAE	*Opuntia polyacantha*	OPPO	NS4S	prickly-pear cactus
	Opuntia fragilis	OPFR	NS4S	brittle cactus
CAPPARIDACEAE	*Cleome lutea*	CLLU	ANF	yellow beeplant
CAPRIFOLIACEAE	*Lonicera sempervirens*	LOSE	IS	honeysuckle
	Sambucus cerulea	SACE	NS	blue elderberry
CARYOPHYLLACEAE	*Arenaria franklinii*	ARFR	NHS	Franklin sandwort
	Cerastium arvense	CEAR	PIF	starry chickweed
	Vaccaria pyramidata[4]	VAPY	AIF	cowcockle

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
CERATOPHYLLACEAE	*Ceratophyllum demersum*	CEDE	PNF2F	hornwort
CHARACEAE	*Chara*	CHARA		
CHENOPODIACEAE	*Atriplex canescens*	ATCA	NS	fourwing saltbrush
	Atriplex patula var. *hastata*	ATPA	ANF	spearleaf saltweed
	Atriplex confertifolia	ATCO	NS	shadscale
	Atriplex rosea	ATRO	AIF	tumbling saltweed
	Bassia hyssopifolia	BAHY	AIF	fivehook bassia
	Ceratoides lanata	CELA	NHS	winterfat
	Chenopodium album	CHAL	AIF	common lamb's quarters
	Chenopodium botrys	CHBO	AIF	Jerusalem oak goosefoot
	Chenopodium foliosum	CHFO	AIF	leafy goosefoot
	Chenopodium incanum[6]	CHIN	ANF	Fremont's goosefoot
	Chenopodium leptophyllum	CHLE	ANF	slimleaf goosefoot
	Chenopodium polyspermum	CHPO	AIF?	
	Chenopodium rubrum	CHRU	ANF	
	Grayia spinosa[5]	GRSP	NS	spiny hopsage
	Halogeton glomeratus	HAGL	AIF	halogeton
	Kochia scoparia	KOSC	AIF	kochia
	Monolepis nuttalliana	MONU	ANF	nuttall monolepis
	Salsola collina	SACO	AIF	
	Salsola kali	SAKA	AIF	Russian thistle
	Sarcobatus vermiculatus	SAVE	NS	greasewood
	Suaeda torreyana[7]	SUTO	NHS	torrey seepweed
CONVOLVULACEAE	*Convolvulus arvensis*	COAR	PIF	morning glory
	Cuscuta indecora[17]	CUIN	PNP2F	dodder
CORNACEAE	*Cornus sericea*[13]	COSE	NS	red-osier dogwood
CUCURBITACEAE	*Echinocystis lobata*[17]	ECLO	ANF	wild mockcucumber

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
CUPRESSACEAE	*Juniperus osteosperma*	JUOS	NT	Utah juniper
	Juniperus scopulorum	JUSC	NT	Rocky Mountain juniper
CYPERACEAE	*Carex hystricina*	CAHY	PNGL	bottlebrush sedge
	Carex lanuginosa	CALA	PNEGL	woolly sedge
	Carex nebrascensis	CANE	PNGL	Nebraska sedge
	Carex rostrata	CARO	PNEGL	beaked sedge
	Carex simulata	CASI	PNGL	mack sedge
	Carex vulpinoidea	CAVU	PNEGL	fox sedge
	Cyperus	CYPER		flat sedge
	Cyperus aristatus	CYAR	ANGL	bearded flatsedge
	Cyperus erythrorhizos	CYER	ANGL	redroot flatsedge
	Cyperus rivularis	CYRI	ANGL	shining flatsedge
	Eleocharis palustris	ELPA	PNEGL	common spikerush
	Eleocharis bella	ELBE	PNGL	beautiful spikerush
	Scirpus	SCIRP		bulrush
	Scirpus acutus	SCAC	PNEGL	tule bulrush
	Scirpus americanus[19]	SCAM	PNEGL	Olney's bulrush
	Scirpus fluviatilis	SCFL	PNEGL	river bulrush
	Scirpus maritimus	SCMA	PNEGL	saltmarsh bulrush
	Scirpus pungens[18]	SCPU	PNEGL	American bulrush
	Scirpus tabernaemontanii[45]	SCTA	PNEGL	soft stem bulrush
DIPSACACEAE	*Dipsacus fullonum*[22]	DIFU	BIF	teasel
ELAEAGNACEAE	*Elaeagnus angustifolia*	ELAN	IS	Russian olive
EQUISETACEAE	*Equisetum arvense*	EQAR	PNH	field horsetail
	Equisetum hyemale	EQHY	PNH	scouring rush
	Equisetum laevigatum	EQLA	PNH	braun horsetail
	Equisetum variegatum	EQVA	PNH	variegated horsetail

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
EUPHORBIACEAE	*Euphorbia*	EUPHO		spurge
	Chamaesyce glyptosperma[20]	CHGL	ANF	corrugate-seeded spurge
	Chamaesyce serpyllifolia[20]	CHSE	ANF	thyme-leaf spurge
FABACEAE[32]	*Astragalus*	ASTRA		
	Astragalus atratus	ASAT	PNF	mourning locoweed
	Astragalus atropubescens	ASAT2	PNF	Kelsey's milkvetch
	Astragalus caricinus	ASCA	PNF	buckwheat locoweed
	Astragalus eremiticus	ASER	PNF	hermit locoweed
	Astragalus filipes	ASFI	PNF	stipate locoweed
	Astragalus geyeri	ASGE	PNF	Geyer locoweed
	Astragalus iodanthus	ASIO	PNF	Humbolt river milkvetch
	Astragalus lentiginosus	ASLE	PNF	specklepod locoweed
	Astragalus malacus	ASMA	PNF	shaggy locoweed
	Astragalus nudisiliquus	ASNU	PNF	cobblestone locoweed
	Astragalus purshii	ASPU	PNF	Pursh locoweed
	Astragalus purshii ophiogenes	ASPUO	PNF	woolly-pod locoweed
	Astragalus toanus	ASTO	PNF	toano poison locoweed
	Caragana arborescens	CAAR	IS	Siberian peashrub
	Dalea ornatum[33]	DAOR	PNF	purple prairieclover
	Glycyrrhiza lepidota	GLLE	PNF	American licorice
	Lotus corniculatus	LOCO	PIF	horned birdsfoot trefoil
	Lotus tenuis	LOTE	PIF	
	Lupinus argenteus	LUAR	PNF	silvery lupine
	Lupinus pusillus	LUPU	ANF	rusty lupine
	Medicago lupulina	MELU	AIF	black medic
	Medicago sativa	MESA	PIF	alfalfa
	Melilotus alba	MEAL	ABIF	white sweetclover
	Melilotus officinalis	MEOF	ABIF	yellow sweetclover
	Psoralea lanceolata	PSLA	PNF	shoestring psoralea
	Robinia pseudo-acacia	ROPS	IT	black locust
	Trifolium	TRIFO		clover

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Trifolium fragiferum	TRFR	PIF	strawberry clover
	Trifolium pratense	TRPR	BPIF	red clover
	Trifolium repens	TRRE	PIF	white clover
GENTIANACEAE	*Centaurium exaltatum*	CEEX	ANF	exalted centaury
	Centaurium muhlenbergii	CEMU	ANF	Muhlenberg centaury
GERANIACEAE	*Erodium cicutarium*	ERCI	AIF	redstem filaree
HALAGORACEAE	*Myriophyllum exalbescens*	MYEX	PNS3F	water-milfoil
HYDROCHARITACEAE	*Elodea canadensis*	ELCA	PNS3F	Canada waterweed
	Elodea longivaginata	ELLO	PNS3F	
	Elodea nuttallii	ELNU	PN3FS	western waterweed
HYDROPHYLLACEAE	*Nama aretioides*	NAAR	ANF	ground nama
	Nama densum	NADE	ANF	leafy nama
	Phacelia hastata	PHHA	PNF	spear shaped phacelia
	Phacelia glandulifera	PHGL	ANF	oak phacelia
IRIDACEAE	*Iris*	IRIS	PIF	iris
JUGLANDACEAE	*Juglans regia*	JURE	IT	English walnut
JUNCACEAE	*Juncus articulatus*	JUAR	PNGL	jointed rush
	Juncus balticus	JUBA	PNGL	arctic rush
	Juncus bufonius	JUBU	ANGL	toad rush
	Juncus torreyi	JUTO	PNGL	Torrey's rush
	Juncus ensifolius	JUEN	PNGL	dagger-leaf rush
	Juncus nodosus	JUNO	PNGL	tuberous rush
LAMIACEAE[31]	*Lycopus americanus*	LYAM	PNF	American bugleweed

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Lycopus asper	LYAS	PNF	rough bugleweed
	Marrubium vulgare	MAVU	PIF	white horehound
	Mentha arvensis	MEAR	PNF	field mint
	Mentha spicata	MESP	PIF	spearmint
	Nepeta cataria	NECA	PIF	catnip
	Scutellaria galericulata	SCGA	PNF	littlecap skullcap
	Teucrium canadense	TECA	PNF	Canada germander
LEMNACEAE	*Lemna*	LEMNA		duckweed
	Lemna minor	LEMI	PNF2F	common duckweed
	Lemna trisulca	LETR	PNF2F	star duckweed
LILIACEAE	*Allium acuminatum*	ALAC	PNF	tapertip onion
	Allium textile	ALTE	PNF	textile onion
	Asparagus officinalis	ASOF	PIF	garden asparagus
	Calochortus bruneaunis	CABR	PNF	Bruneau mariposalily
	Calochortus nuttallii	CANU	PNF	sego mariposalily
	Leucocrinum montanum	LEMO	PNF	sandlily
	Smilacina stellata	SMST	PNF	starry false solomon seal
	Zigadenus venosus	ZIVE	PNF	deathcamas
LOASACEAE	*Mentzelia albicaulis*	MEAL1	ANF	whitestem stickleaf
	Mentzelia laevicaulis	MELA	BNF	smoothstem blazingstar
	Mentzelia torreyi acerosa	METO	ANF	Torrey's blazingstar
LYTHRACEAE	*Lythrum salicaria*	LYSA	PIF	purple loosestrife
MALVACEAE	*Malva neglecta*	MANE	ABIF	common mallow
	Malvella leprosa[34]	MALE	PNF	alkali-mallow
	Sphaeralcea coccinea	SPCO	PNF	scarlet globemallow
	Sphaeralcea grossulariaefolia	SPGR	PNF	gooseberry globemallow
	Sphaeralcea munroana	SPMU	PNF	munro globemallow

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
MORACEAE	*Morus alba*	MOAL	IS	mulberry
NYCTAGINACEAE	*Abronia mellifera*	ABME	PNF	white sandverbena
OLEACEAE	*Fraxinus pennsylvanica*	FRPE	IT	green ash
ONAGRACEAE	*Boisduvalia densiflora*	BODE	ANF	dense spike primrose
	Camissonia boothii[35]	CABO	ANF	Booth's evening-primrose
	Camissonia scapoidea[36]	CASC	ANF	naked-stemmed evening-primrose
	Epilobium spp.	EPILO		willowweed
	Epilobium ciliatum	EPCI	PNF	hairy willowweed
	Epilobium glaberrimum	EPGL	PNF	smooth willowweed
	Epilobium paniculatum?	EPPA	ANF	autumn willowweed
	Epilobium pringleanum?	EPPR		
	Gaura parviflora	GAPA	ANF	smallflower gaura
	Gayophytum ramosissimum	GARA	ANF	branch groundsmoke
	Oenothera biennis	OEBI	BIF	common evening-primrose
	Oenothera caespitosa	OECA	PNF	tufted evening-primrose
	Oenothera hookeri	OEHO	PBNF	hooker evening-primrose
	Oenothera pallida	OEPA	PNF	pale evening-primrose
ORCHIDACEAE	*Epipactis gigantea*	EPGI	PNF	chatterbox orchid
OROBANCHACEAE	*Orobanche*	OROBA	PNP2F	broomrape
	Orobanche californica	ORCA	PNP2F	California broomrape
	Orobanche fasciculata	ORFA	PNP2F	clustered broomrape
PLANTAGINACEAE	*Plantago lanceolata*	PLLA	PIF	buckhorn plantain
	Plantago major	PLMA	PIF	broadleaf plantain
	Plantago patagonica	PLPA	ANF	Indianwheat plantain

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
POACEAE[21]	*Agropyron*	AGROP		wheatgrass
	Agropyron cristatum	AGCR	PIG	crested wheatgrass
	Agropyron dasystachyum	AGDA	PNG	thickspike wheatgrass
	Agropyron intermedium	AGIN	PIF	intermediate wheatgrass
	Agropyron pectinforme	AGPE	PIG	crested wheatgrass
	Agropyron repens	AGRE	PIG	quackgrass
	Agropyron smithii	AGSM	PNG	western wheatgrass
	Agropyron spicatum	AGSP	PIG	bluebunch wheatgrass
	Agrostis exarata	AGEX	PNG	spike bentgrass
	Agrostis stolonifera[24]	AGST	PIG	carpet bentgrass
	Aristida purpurea[48]	ARLO	PNG	three-awn
	Bromus carinatus	BRCA	PNG	California brome
	Bromus commutatus	BRCO	AIG	hairy brome
	Bromus inermis	BRIN	PIG	smooth brome
	Bromus japonicus	BRJA	AIG	Japanese brome
	Bromus tectorum	BRTE	AIG	downy brome
	Dactylis glomerata	DAGL	PIG	orchardgrass
	Digitaria sanguinalis	DISA	AIG	large crabgrass
	Diplachne fascicularis[27]	DIFA	ANG	loose flowered sprangletop
	Distichlis spicata[25]	DISP	PNG	saltgrass
	Echinochloa crusgalli	ECCR	AIG	barnyard grass
	Elymus cinereus	ELCI	PNG	basin wildrye
	Elymus flavescens	ELFL	PNG	yellow wildrye
	Elymus triticoides	ELTR	PNG	creeping wildrye
	Eragrostis cilianensis	ERCI2	AIG	stink lovegrass
	Eragrostis pectinacea	ERPE	ANG	tufted lovegrass
	Eremopyrum triticeum[23]	ERTR	AIG	annual wheatgrass
	Festuca	FESTU		fescue
	Festuca arundinacea	FEAR	PIG	tall fescue
	Glyceria borealis	GLBO	PNG	northern mannagrass
	Glyceria grandis	GLGR	PNG	American mannagrass
	Hordeum glaucum	HOGL	AIG	seagreen barley

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Hordeum jubatum	HOJU	PNG	foxtail barley
	Hordeum pusillum	HOPU	AIG	little barley
	Leersia oryzoides	LEOR	PNG	rice cutgrass
	Lolium perenne	LOPE2	PIG	perennial rye
	Muhlenbergia asperifolia	MUAS	PNG	alkali muhly
	Oryzopsis hymenoides	ORHY	PNG	Indian ricegrass
	Panicum capillare	PACA	ANG	witchgrass
	Phalaris arundinaceae	PHAR	PNG	reed canarygrass
	Phragmites australis[28]	PHAU	PNG	common reed
	Poa compressa	POCO2	PNG	Canada bluegrass
	Poa palustris	POPA	PNG	fowl bluegrass
	Poa pratensis	POPR	PIG	Kentucky bluegrass
	Poa secunda[49]	POSE	PNG	bluegrass
	Poa scabrella	POSC	PNG	pine bluegrass
	Polypogon monspeliensis	POMO	AIG	rabbitfoot grass
	Setaria glauca[29]	SEGL	AIG	yellow bristlegrass
	Setaria viridis	SEVI	AIG	green bristlegrass
	Sitanion hystrix	SIHY	PNG	bottlebrush squirreltail
	Spartina pectinata	SPPE	PNG	prairie cordgrass
	Sphenopholis obtusata	SPOB	PNG	wedgegrass
	Sporobolus airoides	SPAI	PNG	alkali sacaton dropseed
	Sporobolus cryptandrus	SPCR	PNG	sand dropseed
	Stipa comata	STCO	PNG	needle-and-thread grass
	Stipa thurberiana	STTH	PNG	thurber needlegrass
	Taenitherum caput-medusae	TACA	AIG	medusahead
	Triticum aestivum	TRAE	AIG	common wheat
	Vulpia octoflora[26]	VUOC	ANG	sixweeks fescue
POLEMONIACEAE	*Eriastrum wilcoxii*	ERSP	PNF	eriastrum
	Gilia leptomeria	GILE	ANF	slender gilia
	Gilia minutiflora	GIMI	ANF	small-flowered gilia
	Gilia sinuata	GISI	ANF	rosy gilia

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Ipomopsis congesta[37]	GICO	PNF	scarlet gilia
	Langloisia setosissima	LASE1	ANF	moth langloisia
	Leptodactylon pungens	LEPU	NS	granite pricklygilia
	Microsteris gracilis	MIGR	ANF	slender falsephlox
	Phlox	PHLOX		
	Phlox aculeata	PHAC	PNF	sagebrush phlox
	Phlox longifolia	PHLO	PNF	long-leaf phlox
	Polemonium micranthum	POMI	ANF	Jacob's ladder
POLYGONACEAE	*Eriogonum cernuum*	ERCE	ANF	nodding eriogonum
	Eriogonum caespitosum	ERCA	NHS	mat buckwheat
	Eriogonum microthecum	ERMI	NHS	slenderbrush eriogonum
	Eriogonum ochrocephalum	EROC	PNF	woolly eriogonum
	Eriogonum ovalifolium	EROV	PNF	cushion eriogonum
	Eriogonum shockleyi	ERSH	PNF	cowpie buckwheat
	Eriogonum vimineum	ERVI	ANF	broom eriogonum
	Eriogonum watsonii	ERWA	PNF	Watson's buckwheat
	Polygonum spp.	POLYG		knotweed
	Polygonum amphibium[38]	POAM	PNF	water knotweed
	Polygonum aviculare	POAV	ANF	prostate knotweed
	Polygonum coccineum	POCO	PNF	water smartweed
	Polygonum hydropiper	POHY1	AIF	marshpepper knotweed
	Polygonum hydropiperoides	POHY	PNF	swamp knotweed
	Polygonum lapathifolium	POLA	ANF	curltop ladysthumb
	Polygonum persicaria	POPE	AIF	ladysthumb
	Polygonum punctatum	POPU	ANEF	water smartweed
	Polygonum setaceum	POSE2	NI	
	Polygonum Douglasii[39]	PODO	ANF	Douglas knotweeed
	Rumex	RUMEX		dock
	Rumex crispus	RUCR	PNF	curly dock
	Rumex dentatus	RUDE	AIF	toothed dock
	Rumex maritimus[40]	RUMA	ANF	golden dock

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Rumex venosus	RUVE	PNF	veiny dock
POLYPODIACEAE	*Cystopteris fragilis*	CYFR	PNF3	brittle bladderfern
PORTULACACEAE	*Claytonia perfoliata*[46]	CLPE	ANF	miner's lettuce
	Portulaca oleracea	POOL	AIF	common purslane
POTAMOGETONACEAE	*Potamogeton filiformis*	POFI	PNS3F	slender-leaved pondweed
	Potamogeton nodosus	PONO	PNS3F	long-leaved pondweed
	Potamogeton pectinatus	POPE2	PNS3F	fennel-leaved pondweed
	Potamogeton pusillus	POPU2	PNS3F	small pondweed
	Potamogeton strictifolius	POST	PNS3F	
	Potamogeton crispus	POCR	PNS3F	curly pondweed
RANUNCULACEAE	*Aquilegia formosa*	AQFO	PNF	Sitka columbine
	Clematis ligusticifolia	CLLI	NWV	western virgins-bower
	Delphinium nuttallianum	DENU	PNF	Nuttall larkspur
	Myosurus aristatus	MYAR	ANF	sedge mousetail
	Myosurus minimus	MYMI	ANF	tiny mousetail
	Ranunculus	RANUN		buttercup
	Ranunculus aquatilis	RAAQ	PNS3F	water buttercup
	Ranunculus cymbalaria	RACY	PNEF	alkali buttercup
	Ranunculus glaberrimus	RAGL	PNF	sagebrush buttercup
	Ranunculus sceleratus	RASC	PNEF	celeryleaf buttercup
	Ranunculus testiculatus	RATE	AIF	testiculate buttercup
RHAMNACEAE	*Rhamnus cathartica*	RHCA	IS	buckthorn
ROSACEAE	*Amelanchier alnifolia*	AMAL2	NS	saskatoon serviceberry
	Crataegus	CRATA	NS	hawthorn
	Potentilla	POTEN		cinquefoil
	Potentilla anserina	POAN	PNF	goosegrass cinquefoil

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Potentilla biennis	POBI	ANF	biennial cinquefoil
	Potentilla norvegica	PONO	ANF	Norwegian cinquefoil
	Prunus americana	PRAM	NT	American plum
	Prunus institia	PRIN	IT	bullace plum
	Prunus mahaleb	PRMA	IT	grafting cherry
	Prunus spinosa	PRSP	IT	blackthorn
	Prunus virginiana	PRVI	NT	chokecherry
	Purshia tridentata	PUTR	NS	antelope bitterbrush
	Pyrus	PYRUS	IT	pear
	Rosa woodsii	ROWO	NS	Wood's rose
	Rubus discolor	RUDI	IS	Himalayan blackberry
RUBIACEAE	*Galium*	GALIU		
	Galium aparine	GAAP	ANF	catchweed bedstraw
	Galium trifidum	GATR	PNF	threelute bedstraw
SALICACEAE	*Populus alba*	POAL	IT	white poplar
	Populus balsamifera[41]	POBA	NT	black cottonwood
	Populus deltoides	PODE	IT	eastern cottonwood
	Salix	SALIX		willow
	Salix amygdaloides	SAAM	NT	peach-leaved willow
	Salix exigua	SAEX	NS	coyote willow
SAXIFRAGACEAE	*Lithophragma parviflora*	LIPA	PNF	smallflower woodlandstar
	Ribes aureum[30]	RIAU	NS	golden currant
	Ribes cereum[30]	RICE	NS	squaw currant
SCROPHULARIACEAE	*Castilleja angustifolia*	CAAN	PNF	northwestern indian paintbrush
	Castilleja exilis	CAEX	ANF	small indian paintbrush
	Collinsia parviflora	COPA	ANF	blue-eyed Mary
	Linaria genistifolia	LIDA	PIF	brown-leaved toadflax
	Mimulus guttatus	MIGU	ANF	yellow monkeyflower

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
	Penstemon acuminatus	PEAC	PNF	sharpleaf penstemon
	Penstemon cyaneus	PECY	PNF	dark blue penstemon
	Penstemon deustus	PEDE	PNS	scabland penstemon
	Penstemon humilis	PEHU	PNF	low penstemon
	Penstemon radicosus	PERA	PNF	matroot penstemon
	Penstemon speciosus	PESP	PNF	royal penstemon
	Verbascum blattaria	VEBL	BIF	moth mullein
	Verbascum thapsus	VETH	BIF	common mullein
	Veronica anagallis-aquatica	VEAN	BPNEF	water speedwell
	Veronica peregrina	VEPE	ANEF	purslane speedwell
SIMAROUBACEAE	*Ailanthus altissima*	AIAL	IT	giant tree-of-heaven
SOLANACEAE	*Nicotiana attenuata*	NIAT	ANF	coyote tobacco
	Physalis virginiana[42]	PHVI	PNF	
	Solanum	SOLAN		
	Solanum dulcamara	SODU	PIF	bitter nightshade
	Solanum nigrum	SONI	AIF	black nightshade
	Solanum triflorum	SOTR	ANF	cutleaf nightshade
TAMARICACEAE	*Tamarix parviflora*	TAPA	IS	smallflower saltcedar
TYPHACEAE	*Typha latifolia*	TYLA	PNEF	cattail
ULMACEAE	*Celtis reticulata*	CERE	NT	netleaf hackberry
	Ulmus pumila	ULPU	IT	Siberian elm
URTICACEAE	*Parietaria pensylvanica*	PAPE	ANF	pellitory
	Urtica dioica	URDI	PIF	stinging nettle
VERBENACEAE	*Verbena bracteata*	VEBR	PNF	prostrate vervain
	Verbena hastata	VEHA	PNF	blue verbena

Appendix 11. (Continued)

Family	Species	Species Code	Life-form	Common Name
VITACEAE	*Parthenocissus quinquefolia*	PAQU	IWV	Virginia creeper
	Vitis lambrusaca	VILA	IWV	grape
	Vitis vinifera	VIVI	IWV	canyon grape
ZANNICHELLIACEAE	*Zannichellia palustris*	ZAPA	PNS3F	marsh pondweed
ZYGOPHYLLACEAE	*Tribulus terrestris*	TRTE	AIF	puncture vine

Life-forms: A=Annual, B=Biennial, P=Perennial, N=Native, I=Introduced, E=Emergent, F=Forb, G=Grass, GL=Grasslike, H=Horsetail, S=Shrub, T=Tree, WV=Woody vine, HS=Half shrub, F2F=Floating forb, P2F=Parasitic forb, S3F=Submerged forb

Appendix 11. (Continued)

Synomony--Species list reflects current taxonomic standards (Kartesz and Kartesz 1980) that may not occur in Hitchcock and Cronquist (H&C 1978). A list of synonyms (indicated by superscripts within the list) is provided below.

Number	Current name	H&C
1	*Alismaceae*	*Alismataceae*
2	*Toxicodendron radicans*	*Rhus radicans*
3	*Tiquilia nuttallii*	*Coldenia nuttallii*
4	*Vaccaria pyramidata*	*V. segetalis*
5	*Grayia spinosa*	*Atriplex spinosa*
6	*Chenopodium incanum* var. *incanum*	*C. fremontii*
7	*Suaeda torreyana* var. *torreyana*	*S. intermedia*
8	*Asteraceae*	*Compositae*
9	*Aster ericoides* ssp. *pansus*	*A. pansus*
10	*Lactuca tatarica* var. *pulchella*	*L. pulchella*
11	*Malacothrix sonchoides* var. *torreyi*	*M. torreyi*
12	*Euthamia occidentalis*	*Solidago occidentalis*
13	*Cornus sericea* ssp. *sericea*	*C. stolonifera*
14	*Brassicaceae*	*Cruciferae*
15	*Erophila verna*	*Draba verna*
16	*Nasturtium officinale*	*Rorippa nasturtium-aquaticum*
17	*Cuscuta indecora* was included in the *Cuscutaceae* previously	
18	*Scirpus pungens*	*S. americanus*
19	*Scripus americanus*	*S. olneyi*
20	*Chamaesyce*	*Euphorbia*
21	*Poaceae*	*Graminae*
22	*Dipsacus fullonum*	*D. sylvestris*
23	*Eremopyrum triticeum*	*Agropyron triticeum*
24	*Agrostis stolonifera* (2 var.) var. *stolonifera* & var. *palustris*	*A. alba*
25	*Distichlis spicata* var. *stricta*	*D. stricta*
26	*Vulpia octoflora*	*Festuca octoflora*
27	*Diplachne fascicularis*	*Leptochloa fascicularis*
28	*Phragmites australis*	*P. communis*
29	*Setaria glauca*	*S. lutescens*

Appendix 11. (Continued)

Number	Current name	H&C
30	*Ribes* was included in *Grossulariaceae* previously.	
31	*Lamiaceae*	*Labiatae*
32	*Fabaceae*	*Leguminosae*
33	*Dalea ornatum*	*Petalostemon ornatum*
34	*Malvella leprosa*	*Sida hederacea*
35	*Camissonia boothii* ssp. *alyssoides*	*Oenothera boothii*
36	*Camissonia scapoidea*	*Oenothera scapoidea*
37	*Ipomopis congesta*	*Gilia congesta*
38	*Polygonum amphibium* var. *emersum*	*P. coccineum*
39	*Polygonum sawatchense*	*P. douglasii v. johnstonii*
40	*Rumex maritimus* var. *persicarioides*	*R. persicarioides*
41	*Populus balsamifera* ssp. *trichocarpa*	*P. trichocarpa*
42	*Physalis virginia* var. *sonorae*	*P. longifolia*
43	*Apiaceae*	*Umbelliferae*
44	*Rorippa palustris*	*R. islandica* (depends on variety)
45	*Scripus tabernaemontanii*	*S. validus*
46	*Claytonia perfoliata*	*Montia perfoliata*
47	*Aster foliosus*	*A. chilensis*
48	*Aristida purpurea*	*A. longiseta*
49	*Poa secunda*	*P. nevadensis and P. sandbergii*